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ORIGINAL ARTICLES

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WALTER M. SOLOMON, M.D.
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THE COMPARATIVE EFFECTIVENESS OF VARIOUS ELECTRICAL CURRENTS IN PREVENTING MUSCLE ATROPHY IN THE RAT *

A. J. KOSMAN, Ph.D.
S. L. OSBORNE, Ph.D.
and
A. C. IVY, M.D., Ph.D.
CHICAGO

Various types of electrical stimulation have been used both experimentally and clinically for the prevention or retardation of the atrophy of denervated skeletal muscle. In common clinical use are a surging uninterrupted direct current with alternate polarity ("slow sinusoidal") and an interrupted direct (galvanic) current. In animal experimentation most investigators have used condenser discharge, induced (faradic) current, interrupted direct and alternating currents.

On a theoretic basis, Grodins, Osborne and Ivy[1] postulated that the most effective form of electrical stimulation of denervated muscle should be a modulated alternating current with a carrier frequency of approximately 25 cycles per second. In later experiments this assumption was amply confirmed.[2] Solandt, De Lury and Hunter[3] compared the relative abilities of induced, interrupted direct, 60 cycle, A. C., and 25 cycle, A. C. in retarding the weight loss of denervated rat muscles. These authors concluded that the 25 cycle, A. C., was the most effective current, followed in order of effectiveness by 60 cycle, A. C., induced current and interrupted direct current. Recently, Wehrmacher, Thomson and Hines,[4] using a technic of stimulation in which the denervated muscle was kept at a full stretch during the period of stimulation, reported that they were able to obtain a greater degree of atrophy retardation by using an induced current than had been obtained by Grodins and co-workers.[2a] These authors concluded that the particular form of electrical current was of no importance so long as it produced maximal tension in the denervated muscle.

In a preliminary report[5] we presented evidence indicating the relative ineffectiveness of the surging uninterrupted direct ("slow sinusoidal") and interrupted direct currents in preventing the weight and strength loss of denervated skeletal muscle. In the experiments reported here we have extended these investigations to include answers to the following questions:

1. Do the various currents influence the course of atrophy to the same extent when (*a*) maximal stimuli are employed and (*b*) when current intensities which can be tolerated by the animal are employed?

2. Do the various currents produce identical amounts of tension in the muscle at (*a*) maximal intensities and (*b*) at pain threshold intensities?

* From the Departments of Physiology and Physical Medicine, Northwestern University Medical School. This work was aided by a grant from The National Foundation for Infantile Paralysis, Inc.

1. Grodins, F. S.; Osborne, S. L., and Ivy, A. C.: Present Status of Electrical Stimulation of Denervated Muscle, Arch. Phys. Therapy 23:729, 1942.

2. (*a*) Grodins, F. S.; Osborne, S. L.; Johnson, F. R., and Ivy, A. C.: Stimulation of Denervated Skeletal Muscle with Alternating Current, Am. J. Physiol. 142:216, 1944. (*b*) Grodins, F. S.; Osborne, S.L.; Johnson, F. R.; Arana, S., and Ivy, A. C.: The Effect of Appropriate Electrical Stimulation on Atrophy of Denervated Skeletal Muscle in the Rat, ibid. 142:222, 1944.

3. Solandt, D. Y.; De Lury, D. B., and Hunter, J.: Effect of Electrical Stimulation on Atrophy of Denervated Skeletal Muscle, Arch. Neurol. & Psychiat. 49:802, 1945.

4. Wehrmacher, W. N.; Thomson, J. D., and Hines, H. M.: Effects of Electrical Stimulation on Denervated Skeletal Muscle, This Journal 26:261, 1945.

5. Kosman, A. J.; Osborne, S. L., and Ivy, A. C.: The Effect of Various Types of Electrical Stimulation and of Frequency of Stimulation upon Muscle Atrophy in the Rat, Fed. Proceedings 4:41, 1945.

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Methods and Materials

Male adult albino rats weighing 225 to 275 Gm. were used throughout this study. A large section of the sciatic nerve was removed bilaterally. The animals were divided into the following groups:

I. *No Treatment Group: 75 Rats.* — The animals were killed from seven to fourteen days after the nerve section, and the amount of tension developed by the gastrocnemius muscles was determined when the supramaximal stimuli of the following currents were employed: 0,5, 5, 10, 25, 50, 100, 250, 500 cycles per second, induced current by means of a Harvard Inductorium and an interrupted direct current. Obviously not all of these stimuli could be applied to the same muscle. In practice, about three or four currents could be used in a single experiment before fatigue effects made the results untrustworthy. The sequence of the applied stimuli was varied from muscle to muscle.

II. *No Treatment Group: 80 Rats.* — As in Group I, the rats were killed between the seventh and the fourteenth day following nerve section. The amount of tension developed by the muscles was determined as the current intensity was varied from subthreshold to maximal values. The muscle tensions thus obtained were then plotted against the corresponding intensity in milliamperes and a muscle tension—current intensity curve constructed. Such curves were fashioned for the following currents: 0.5, 5, 10, 25, 100, 250, 500 cycles per second, interrupted direct and induced current.

III. *Treated Group: 113 Rats.* — The gastrocnemius on one side was stimulated twice daily for thirty seconds with one of the following currents and intensities: modulated A. C. with a carrier frequency of 25 cycles, 6 ma; interrupted direct, 10 ma; surging uninterrupted direct with alternate polarity, 25 ma; induced current from a Harvard Inductorium, secondary at 3 cms. The unanesthetized rats were held by one person and a felt padded electrode clipped to the skin of the thigh; a small stimulating electrode, shaped to fit around the achilles tendon, was applied by a second person, who held the foot against the tibia and kept the knee joint fixed at a 90 degree angle during the entire stimulation period. Electrical stimulation was started the day following denervation and was continued until the fourteenth day, when the animals were killed. Muscle tensions and wet weights were determined for both treated and control gastrocnemii. One hundred and twenty rats were studied to find the ratio of tension to body weight of the normal gastrocnemius. The normal muscle weight: body weight ratio was found to be 0.0057 per cent and normal muscle tension: body weight ratio was 8.7 per cent.

IV. *Treated Group.* — The muscle on one side was stimulated in the manner just described. However, the intensity of the stimulating current was adjusted to the pain tolerance of the animal. Admittedly, in an animal such as the rat, it is difficult to estimate very accurately the painfulness of any particular procedure. As a result of repeated observations on many rats, we considered as reasonable approximations of pain the following criteria: (1) struggling of the animal during the entire stimulation period; (2) spread of the stimulation to remote muscles; (3) squealing during entire period of stimulation; (4) absence of any training effects with repeated stimulation. The currents and intensities employed were: 25 cycle modulated A. C., 3 ma; induced current, secondary coil at 7 cms.; interrupted direct, 3 ma; surging uninterrupted direct with alternate polarity, 15 ma.

Experimental Results

I. *Tension Development by Supramaximal Stimuli.* — These results are graphically represented in chart 1. It is apparent that the amount of tension which can be developed by the muscle following maximal stimulation depends upon the type of current which is used. The greatest tension was produced with alternating currents at frequencies of 25 to 100 c.p.s., and with induced currents. There is a definite relationship between the frequency of the alternating current and tension development. With carrier frequencies above 100 c.p.s. and below 25 c.p.s., the tension developed decreases sharply. Thus, at 10 c.p.s. the tension is 75 per cent and at 5 c.p.s. is 70 per cent of that produced with 25 cycle stimulation; and at 250 and 500 cycles, it is 75 per cent and 65 per cent, respectively.

Stimulation with interrupted direct and 0.5 cycle, A. C. currents resulted in fractional values of maximal possible tension, e.g., 63 per cent and 48 per cent, respectively. To summarize, there is an optimum frequency at which electrical stimuli must reach the muscle in order to produce a maximum

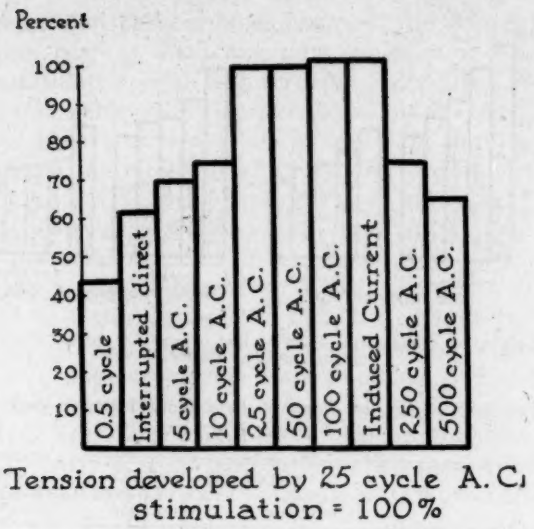

Chart 1. — Comparative effectiveness of various currents in developing muscle tension with supramaximal stimuli.

effect upon muscle tension. This optimum lies between 25 and 100 c.p.s.; above and below these values, electrical stimuli exert progressively decreasing effects upon tension development.

II. *Intensity-Tension Curves for Various Currents.* — In constructing intensity tension curves for denervated muscle, it is evident that the shape of the curve depends upon the nature of the electrical current which is employed (chart 2). Thus, when a 25 cycle current is used, the curve is the steepest;

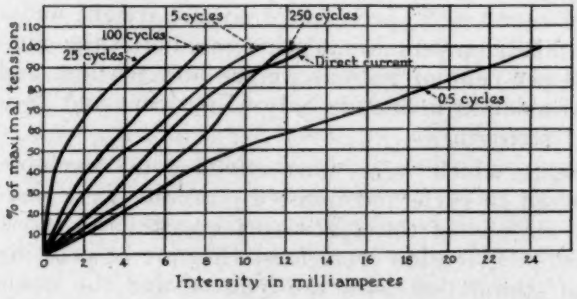

Chart 2. — Intensity-tension curves for the various currents

and at 1 ma the tension developed is one-half that obtained with maximal stimulation. When surging direct at 0.5 c.p.s. is the stimulating current, the curve has the slowest rise and at 10 ma, develops only 50 per cent of the tension produced with maximal stimuli. The curves obtained when the other currents are used fall between these two extremes. Thus, although identical amounts of muscle tension may result from maximal stimulation with various currents, the relationship between current intensity and tension may vary widely from one current to another. These differences among the various currents are especially significant at current intensities which can be tolerated by the experimental animals. At these intensities, the modulated 25 cycle current is by far the most effective in producing muscle tension.

III. *Effect of Supramaximal Stimuli Upon Retardation of Atrophy.* — These results are summarized in the table and chart 3. When maximal

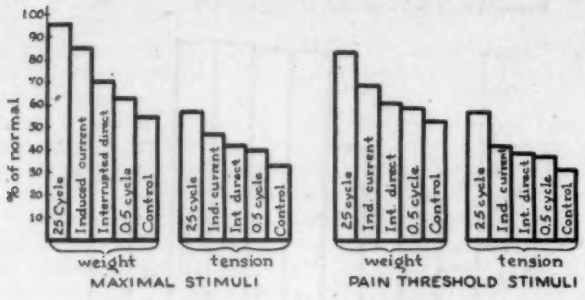

Chart 3. — Comparative effectiveness of various currents in retarding muscle atrophy.

Percentage Differences in Weight and Tension Between Untreated and Treated Muscles for the Various Currents.

Type of Current	% Difference Weight — Maximal Stimulation	% Difference Weight — Pain Threshold Stimulation	% Difference Tension — Maximal Stimulation	% Difference Tension — Pain Threshold Stimulation
(30)* cycle, A. C.	78.0	54.5	74.5	75.0
(30) Induced	62.5	31.7	50.5	33.0
(27) Interrupted direct	31.0	14.6	31.3	26.8
(26) 0.5 cycle, A. C.	15.1	12.8	20.0	23.3

* Figures in parentheses represent number of animals used.

stimuli are used, all muscles treated with the various currents showed a definite retardation of atrophy. However, wide differences are apparent in the effectiveness with which the currents can maintain the weight and strength of the denervated muscle. Thus, for instance, the induced current stimulation maintains the muscle at 86 per cent and 45 per cent of normal weight and tension, respectively; the modulated 25 cycle A. C. stimulation maintains 94 per cent and 56 per cent of normal weight and strength; while the interrupted direct current stimulation maintains the muscle at only 68 per cent and 40 per cent of normal weight and tension, and the 0.5 cycle A. C. current stimulation maintains only 63 per cent and 38 per cent of normal weight and strength.

Those currents which were most effective in developing muscle tension, the modulated 25 cycle and induced currents, were also most effective in delaying the atrophy of the denervated muscle, and those currents least effective in developing tension were least effective in delaying atrophy. Although maximal stimulation with the induced and the modulated 25 cycle currents produce equal amounts of muscle tension, the muscles which were treated with the modulated 25 cycle A. C. were significantly heavier and stronger than those treated with induction shocks. This difference may be due to an unusual loss of body weight suffered by the animals stimulated with induced currents. This procedure was extremely painful, and the spread of the stimuli to other muscles was extensive enough to produce spasm of the respiratory muscles.

IV. *Effect of Pain Threshold Stimuli Upon Retardation of Atrophy.* — When the denervated muscles are stimulated with currents of pain threshold intensity, there is a corresponding decrease in the extent to which the atrophy is prevented and the differences in the effectiveness of the various currents become more pronounced. The modulated 25 cycle current is definitely the most effective in maintaining weight and strength: 89 per cent of normal weight and 56 per cent of normal tension. Stimulation with induction shocks maintains the muscle at 76 per cent and 40 per cent of normal weight and

tension, interrupted direct current at 68 per cent and 38 per cent and surging uninterrupted direct current with alternate polarity at 60 per cent and 37 per cent. Thus, stimulation with uninterrupted direct and surging direct with alternate polarity (0.5 cycle, A. C.) is not particularly effective in the re-tardation of atrophy when pain threshold stimuli are employed. Stimulation with induced currents definitely delays atrophy, but it is far less effective than 25 cycle stimulation. These differences in the ability of the currents to prevent atrophy can be correlated with their ability to produce tension in the muscles at these intensities. Twenty-five cycle A. C., which produces the greatest tension at low intensities, is also the most effective in maintaining the weight and strength of the denervated muscle.

It is interesting to note that although stimulation with 25 cycle current at 6 ma, results in a heavier muscle than at 3 ma, the muscle strength at the two intensities is essentially the same. It appears that under the particular conditions of stimulation employed the full beneficial effects of the modulated 25 cycle current upon the functional capacity of the denervated muscle are already realized at the more moderate current intensities.

Comment

Much experimental evidence has been accumulated to show that electrical stimulation of denervated muscle can retard its atrophy to a considerable extent if vigorous contractions and sufficient tension can be produced in the muscle. The results of the experiments reported in this paper demonstrate the close correlation between the ability of a current to produce tension in a muscle and its ability to maintain the paralyzed muscle. But, from a practical point of view, it is necessary not only that a current must produce a vigorous response in the denervated muscle, but that it can do this at current intensities which can be tolerated by the patient. From this point of view a surging uninterrupted direct current with alternate polarity is undoubtedly of greater clinical value than the induced current, despite the greater experimental effectiveness of the latter. For, although induction shocks can produce considerable tension in the experimentally paralyzed muscle with maximal stimuli, its extreme painfuliness has made its clinical use prohibitive except for diagnostic purposes. On the other hand, the well known tolerance of patients to high intensities of surging uninterrupted direct current with alternate polarity enables the therapist to employ, in effect, maximal stimuli.

However, if one considers as the criteria for an ideal current for electrical stimulation of denervated muscle (1) vigorous muscle responses at low current intensities and (2) selective stimulation of denervated muscle, then a modulated alternating current of 10 to 25 cycles fulfils these requirements more exactly than other currents which have been tried experimentally and clinically. We have employed this current, in low intensities, in the treatment of human subjects (including some with early acute polioymelitis) to produce vigorous muscle contractions with relatively little discomfort.

Summary

1. When supramaximal stimuli are employed, the order of effectiveness of various electrical currents in producing tension in the denervated muscle is: 25 cycle = 100 cycle = induced current > 10 cycle > 250 cycle > 5 > 500 cycle > interrupted direct > surging direct with alternate polarity.

2. When pain threshold intensities are employed, the order of effectiveness is 25 cycle > 100 cycle >5 cycle > interrupted direct > 250 cycle > surging direct with alternate polarity.

3. The order of effectiveness of various currents in retarding the atrophy of denervated rat muscles when supramaximal stimuli are employed

is 25 cycle > induced current > interrupted direct > surging direct with alternate polarity.

4. When these currents are employed at more moderate intensities, the order of effectiveness remains the same but the superiority of the 25 cycle curves becomes more pronounced.

5. The characteristics of a practical current for electrical stimulation of denervated muscles are briefly discussed.

THE INFLUENCE OF DURATION AND FREQUENCY OF TREATMENT IN ELECTRICAL STIMULATION OF PARALYZED MUSCLE *

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and

A. C. IVY, M.D., Ph.D.

CHICAGO

The frequency of treatment and the duration of each treatment when using electrical stimulation for the denervated muscle is of great practical importance in clinical electrotherapy. As yet, the procedure which is effective in minimizing the atrophy of the denervated muscle based on the optimum number and duration of the stimulation periods has not been generally agreed upon by clinicians.

In the past several years experimental evidence has accumulated which indicates that the more frequently a denervated muscle is stimulated the better is the maintenance of its weight and strength.[1a] In addition, there is apparently an optimum duration of the stimulation during which all of the beneficial effects of the treatment are realized. When the electrical stimulation is continued beyond this point, it does not in any way add to its effectiveness.

In the present report we shall present some additional experimental evidence which confirms these observations and may provide a rational basis for a practical regimen of electrical stimulation of paralyzed muscles.

Methods

As in previous studies, adult male albino rats weighing from 225 to 275 Gm. were used. A large section of the sciatic nerve was removed bilaterally, and the gastrocnemius on one side was stimulated with a modulated alternating current with a carrier frequency of 25 cycles and modulated to produce 40 contractions per minute at a current intensity of 3 ma. The manner, frequency and duration of the treatments were arranged as follows:

Group I. — The gastrocnemius was stimulated once daily and caused to contract against a load of 25 Gm. The length of the daily stimulation periods was as follows: 10 rats, one minute; 10 rats, three minutes; 10 rats, five minutes; 10 rats, ten minutes; 10 rats, fifteen minutes. The animals were killed on the fourteenth day, and the wet

* From the Departments of Physiology and Physical Medicine, Northwestern University Medical School. This work was aided by a grant from The National Foundation for Infantile Paralysis, Inc.

1. (*a*) Solandt, D. Y.; DeLury, D. B., and Hunter, J.: Effect of Electrical Stimulation on Atrophy of Denervated Skeletal Muscle, Arch. Neurol. & Psychiat. 49:802, 1943. (*b*) Wehrmacher, W. N.; Thompson, J. D., and Hines, H. M.: Effects of Electrical Stimulation on Denervated Skeletal Muscle, Arch. Phys. Med. 26:261, 1945. (*c*) Kosman, A. J.; Osborne, S. L., and Ivy, A. C.: The Effect of Various Types of Electrical Stimulation and of Frequency of Stimulation Upon Muscle Atrophy in the Rat, Fed. Proc. 4:11, 1945.

weights and muscle strengths of both treated and untreated gastrocnemium were determined.

Group II. — In this group, the gastrocnemius was placed on a full stretch and was not permitted to shorten appreciably during its contraction. In one group, the animals were treated once daily and the duration of each treatment varied as follows: 17 rats, thirty seconds daily; 10 rats, one minute daily; 10 rats, ten minutes daily. The animals were killed on the fourteenth day, and the wet weights and muscle strengths of both treated and control muscles were determined.

In a second group, the duration of each stimulation period was kept at thirty seconds, and the number of treatment periods varied as follows: 17 rats, once daily; 15 rats, twice daily; 25 rats, three times daily; 10 rats, five times daily; 10 rats, six times daily. The animals were killed on the fourteenth day in the manner described, with the exception of 10 animals from the group treated three times daily, which were treated for twenty-eight days before they were killed.

A third group of rats were stimulated three times daily at intervals spaced in the following manner: 10 rats, two minutes' rest between stimulations; 10 rats, five minutes' rest between stimulations; 11 rats, ten minutes' rest between stimulations. All the animals were killed on the fourteenth day, and wet weights and muscle strengths of both gastrocnemii were determined in the usual manner.

Results

Effects of Varying Duration of Stimulation. — These results are summarized in table 1. The differences in weight and tension between stimulated and

TABLE 1. — *Influence of Duration of Stimulation Upon Muscle Atrophy.*

No. Animals	Duration of Stimulation	% Diff. Weight	% Diff. Tension	
10	1 min.	18.1	41.2	Muscle contractions against 25 Gm. load
10	3 min.	17.1	37.6	
10	5 min.	16.7	41.7	
10	10 min.	19.6	39.7	
10	15 min.	19.5	38.5	
17	30 sec.	40.3	61.5	Muscle in "stretch" position
10	1 min.	42.8	58.7	
10	10 min.	40.2	59.3	

control muscles are essentially the same whether the muscle is stimulated for one-half, one or fifteen minutes. The beneficial effects of electrical exercise occur within the first minute, and, although prolonging the stimulation beyond this point does not cause any apparent damage to the muscle, it does not add in any way to the effectiveness of the electrical stimulation in preventing atrophy of the denervated muscle. The prevention of atrophy is markedly enhanced when the muscle is maintained in the stretched position during stimulation. These findings confirm the observations of Eccles[2] and especially of Wehrmacher and Hines[1b] (table 1).

Solandt[1a] has demonstrated a linear relationship between the number of daily stimulation periods and the maintenance of muscle mass. In our experiments, this linear relationship approximately holds until the muscle reaches near normal values for weight when treated 3 times daily (table 2, chart 1). Increasing the number of stimulation periods to six per day results in relatively little additional improvement in weight. The relationship between tension and the number of daily treatments is quite different (table 2, chart 1). A marked improvement in muscle tension occurs as the stimulation periods are increased to two daily; a smaller additional increase at three stimulations a day and no significant additional improvement up to 6 stimulations per day although the muscle is still only 63 per cent of normal. Thus, with the methods of electrical stimulation employed in this study

2. Eccles, J. C.: Investigations on Muscle Atrophies Arising from Disuse and Tenotomy, J. Physiol, 103:253, 1944.

maximal retardation of atrophy is practically effected when the denervated muscle is stimulated three times daily and beyond this point, the law of diminishing returns may be said to be operating.

It has been experimentally established that electrical stimulation delays the atrophy of denervated muscle only if vigorous contractions or consider-

TABLE 2. — *Influence of Frequency of Stimulation Upon Muscle Atrophy.*

No. Animals	No. Treat.	% Diff. Weight	% Diff. Tension
17	1	40.3	61.5
15	2	54.5	80.5
25	3	73.5	89.1
10	5	83.5	92.0
10	6	84.1	94.5
10	3	114.8	215.0 (treated 28 days)

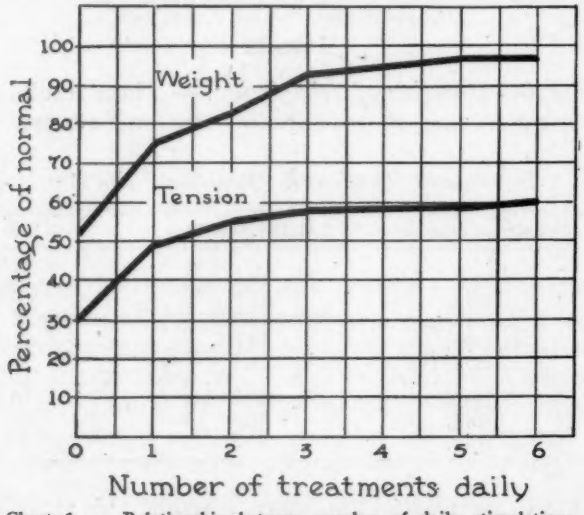

Chart 1. — Relationship between number of daily stimulations and retardation of atrophy.

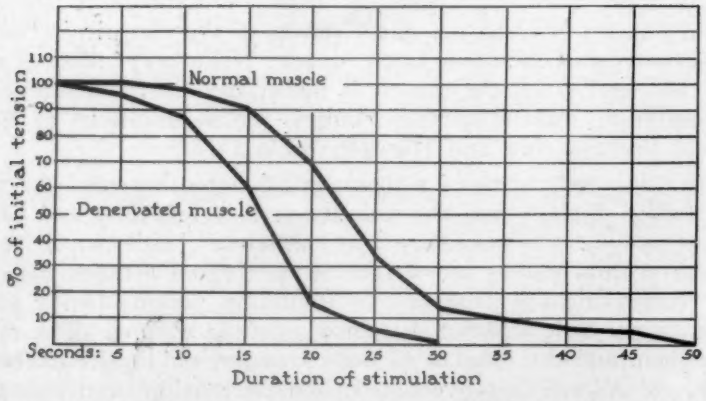

Chart 2. — Fatigue curve of normal and denervated muscle when stimulated continuously.

able tension are produced in the muscle. Since such brief periods of stimulation are so effective in reducing the weight and strength loss of denervated muscle, the relationship between the duration of the stimulation and the

amount of tension developed by the muscle was investigated. Both denervated and normal rat gastrocnemii were subjected to either continuous or intermittent (thirty per minute) maximal stimulation with the modulated 25 cycle alternating current and the tension developed by the muscles was measured during the entire course of the stimulation. These results are shown in chart 2. When denervated muscle is stimulated continuously the tension developed by the muscle decreases very rapidly from its initial values. After twenty seconds' stimulation, it is about 15 per cent of the initial tension and is practically 0 after thirty seconds. Under these conditions, denervated muscle loses its ability to develop tension about twice as fast as normal muscle. When the muscle is stimulated intermittently the tension which is developed falls off more slowly than with continuous stimulation (chart 3).

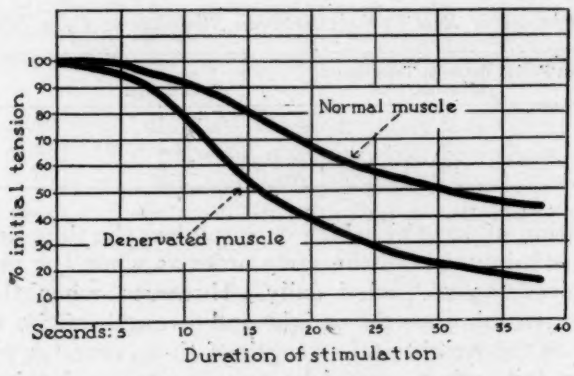

Chart 3. — Fatigue curve of normal and denervated muscle when stimulated intermittently.

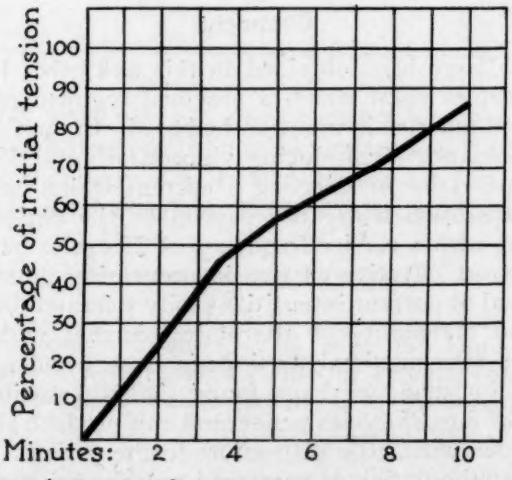

Chart 4. — Time course for recovery of completely fatigued denervated muscle.

However, the decrease still occurs at rather a rapid rate, e.g., after twenty seconds it is 40 per cent and after thirty seconds it is less than 10 per cent of the initial tension values. Since tension development is so essential in the amelioration of muscle atrophy, the effectiveness of electrical stimulation is necessarily limited to the period during which it causes vigorous responses

in the denervated muscle. For rat muscles this period is apparently rather short, viz. one minute or less.

When a denervated rat muscle is stimulated intermittently for thirty seconds and then rested for varying lengths of time before a second period of stimulation it is found that no significant recovery to initial tension values occurs until ten minutes has elapsed (chart 4). Denervated muscle fatigues rapidly and recovers slowly. There is no good reason for stimulating the muscle after definite signs of fatigue appear or for resuming its stimulation until it has been sufficiently rested. This correlation between the effectiveness of the electrical stimulation and recovery from fatigue is well demonstrated by the results obtained with the group of animals which were stimulated for three thirty second periods daily with two, five or ten minutes' rest between the stimulations (table 3).

TABLE 3. — *Influence of Rest Periods Between Stimulations Upon Muscle Atrophy.*

No. Animals	Rest Period Between Treatments (Minutes)	% Diff. Wt.	% Diff. Tension
10	2	43.5	59.8
10	5	41.1	57.8
11	10	55.8	86.6

The retardation of atrophy which occurs when the time between stimulation is two or five minutes is of the same order as when the muscle is treated for only one thirty second period daily. However, when the rest interval is lengthened to ten minutes, the weight and strength of the treated muscles are comparable to the weight and strength of those muscles which have been stimulated twice daily when several hours separated each stimulation period. Thus, when the muscle is rested for a suitable period between stimulations, the beneficial effects of frequent and repeated treatments can be obtained.

Comment

Sufficient data have been obtained in this and other laboratories to establish some principles upon which a practical regimen of electrical stimulation of denervated muscles in man can be based. In another paper[3] we have indicated the importance of producing vigorous contractions of the treated muscles and the necessity of selecting a current which can accomplish this at current intensities which are not painful to the patient. A modulated alternating current with a carrier frequency of 25 cycles per second has been shown to be the most effective current in preventing muscle atrophy in the experimental animal at current intensities easily tolerated by the animal. We have demonstrated the ability of alternating current with this carrier frequency to produce near maximal tensions in denervated muscle at low current intensities. For man, we have found that alternating current with a carrier frequency of 5 to 25 cycles per second can produce strong contractions of paralyzed muscles with little discomfort to the patient. A first requisite, then, is the proper stimulation of paralyzed muscles with a stimulator which furnishes such currents.

Continuation of the stimulation after the muscle has shown signs of fatigue serves no useful purpose. The muscle should be treated daily with brief periods of stimulation and rest. There is little exprimental basis for a long continuous session of electrical exercise. By short periods of treatment with adequate rests between, the advantages of multiple daily stimulations can be obtained in the time usually spent in the clinic. We have found

3. Kosman, A. J.; Osborne, S. L., and Ivy, A. C.: The Comparative Effectiveness of Various Electrical Currents in Preventing Muscle Atrophy in the Rat, Arch. Phys. Med., this issue, p. 7.

such a procedure to be immensely satisfactory in our clinic, especially when treatment involves the stimulation of several muscles in the same patient.

Summary

1. Brief periods of stimulation (thirty seconds) are as effective as longer periods (fifteen minutes) in the retardation of denervation atrophy of the gastrocnemius muscles of the rat.

2. Increasing the number of daily stimulations to three per day increases the effectiveness of the electrical stimulation in maintaining the weight and strength of denervated rat muscles. However, increasing the number of treatments beyond this (six per day) does not result in any further improvement in weight and strength.

3. The equal effectiveness of short and long treatment periods is related to the fact that denervated rat muscle fatigues very rapidly.

4. The recovery time of fatigued denervated rat muscle was determined. Substantial recovery does not occur until the muscle is rested at least ten minutes.

5. When denervated muscles are stimulated three times daily with a two, five or ten minute rest between stimulations, only those muscles rested for ten minutes benefitted from the multiple stimulation.

6. These results are discussed in outlining a rationale for clinical electrical stimulation of paralyzed muscles.

See page 63 for announcement of one day session, Midwestern Section of Congress to be held Friday, February 14, 1947, Officers Club, Percy Jones General Hospital, Battle Creek, Michigan.

See pages 2 and 3 this issue for complete schedule of postgraduate course in Physical Medicine, Galveston, Texas, March 3, 4, 5, 6 and 7, 1947.

BED EXERCISES

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It has long been an accepted premise in the practice of medicine that a patient must be put at rest in order to give the healing forces of nature an opportunity to make him well again. It has been only in the past few years that this hypothesis has been examined. This examination was made necessary because of the shortage of man power during the war. The results have been not only instructive but, in many instances, astounding. The old premise of bed rest per se has been disproved time after time.

The average patient in a hospital suffers 10 per cent of the time from pain and 90 per cent from boredom. This was particularly true in military hospitals at the start of the war. During that time, when every man was badly needed, there were approximately fifty thousand men sitting around in military hospitals just waiting for time and nature to complete their convalescence. Definitive medical and surgical care had been accomplished. They were bored with sitting around with nothing to do until they were able to go back on the job.

At this time, the Convalescent Training Program was started by the Army Air Forces. The objective of this program was to return the men to duty as soon as possible through (*a*) a program of physical exercise and (*b*) an educational program designed to keep them mentally alert while at the same time they could be taught certain things that might be of value to them later, either in their military or in their civilian life.

The results of such a program have been exceptional. Many men were able to leave the hospital at a much earlier date than was ever believed possible before. Some of these men returned to duty in better physical condition than they had been in before they become ill.

When this program had been established, the period of convalescence in certain acute infectious and contagious diseases was reduced by 30 to 40 per cent. One hospital reported a reduction from eighteen to eleven days in the convalescence of patients with measles and a drop from thirty-three to twenty-three hospital days in convalescents with scarlet fever. A study of 645 cases of primary atypical pneumonia, divided into parallel groups, with one as a control, revealed that the group permitted to convalesce in the usual routine manner averaged forty-five days of hospitalization with a 30 per cent recurrence rate. The group that participated in the Convalescent Training Program averaged thirty-one days of hospitalization, with but 3 per cent recurrence rate.

I was given the opportunity of observing the results of this program from the time of its inception and felt that similar results could be accomplished with civilian patients.

During the ten years preceding this, it had been my practice to instruct my obstetrical patients before and after delivery in pelvis tilting, abdominal breathing and in posture exercises. Occasionally I did the same for postoperative patients, but not until the eighth or tenth day. The work was not carried on in a too consistent manner during that time, I will admit, although I was convinced of its value.

After observing the Air Forces work, early in 1944 I set up a series of specific bed exercises. I instituted these for all my postoperative patients within twenty-four to forty-eight hours after operation and for my medical patients at the times when I felt them advisable.

The pressure of a general practice during wartime did not allow me to keep accurate records on these patients. The observations made were not put on paper, although I am sure, had I the time, I could go back and extract the data from the patient's charts.

The surgery was done by two physicians who are members of the American College of Surgeons. I served as the assistant in surgery on all the patients I referred to these two surgeons. It is that group of patients for whom exercises were instituted. There were approximately 75 in this group in a year's time.

Only medical patients who were acutely or seriously ill or those in need of special medical treatment could be admitted to the hospital in this time, owing to the shortage of hospital beds.

Consequently, while this group is small, the severity of the illness should make the study of more value. The patients with arthritis who were permitted to enter the hospital for special treatment added to the interest of the study.

What Is Meant by Bed Exercises?

Bed exercises are those exercises devised for a person who is ill and in bed, whether he is at home or in the hospital. They are exercises which if used correctly will constitute a distinct part of a patient's medical treatment. When they are to be instituted as treatment will vary with other factors in the patient's illness and will be considered later.

It is important to understand first of all what is to be accomplished.

Dr. Ansel Keys, in his reports to the National Research Council, has conclusively proved the effect of complete physical inactivity on the blood chemistry of normal adults with three to four weeks of rest in bed. In a typical case, no important change was found in body weight. A negative nitrogen balance, a slightly negative potassium balance and an increase in the excretion of thiamine and riboflavin, were found, but there were no significant changes in calcium and phosphorus balance.

It has also been proved by Keys and other investigators that it is almost impossible to maintain the normal blood chemical balances, even with particular attention to the diet and with parenteral additions of these substances, as long as the patient is inactive. One of the best ways to activate a patient, then, is by bed exercises. Other reports presented to the National Research Council demonstrated distinct changes in pulse rate also. There is an increase in the pulse rate and a decrease in the pulse pressure in the upright position at the end of a period of bed rest. The heart size decreases during this same period.

Therefore, bed exercises accomplish these things:

1. The activity helps to maintain blood chemistry balances.

2. The decrease in the size of the heart during inactivity, with the rise in pulse rate and a corresponding fall in pulse pressure, is better compensated for.

3. Bed exercises instituted as early as is possible in any patient's illness will help maintain the patient's muscle tone. When muscle tone is maintained, at the time the patient is able to get out of bed he will then have muscles on which he can stand and move with greater ease. This distinctly lessens the work load, since less exertion is called for to do the fundamental tasks of standing and moving, but it is done with stronger muscles. When less energy is needed to perform a task, the efficiency of that task is increased by the ease with which it is done. Hence it requires less effort to perform the same task. The accompanying weakness is also lessened. That this

weakness does occur, and quickly, every one has observed when he has spent even as little as two or three days in bed with nothing more serious than a common cold.

4. Before exercises are instituted, the patient is taught the proper positions in which he should lie to cause the least stress and strain to individual muscle groups and the relation of those to the body as a whole. These correct positions prevent the development of deformities. Also from these positions of election relaxation itself must be definitely taught preliminary to the teaching of the actual exercises.

5. Finally, the activity helps to speed up all other physiologic processes. Activity of the kidneys and bowels become normal more quickly; healing is accelerated, and the patient is far less uncomfortable early in his illness (particularly if it is a surgical case), because all his physiologic processes are functioning in a more nearly normal fashion, while he himself is not made more uncomfortable by tired, tense, strained and weakened muscles. Further, because he is less uncomfortable, he is able to eat solid food earlier and with an appetite. Thus he is stronger and feels better because of a more adequate caloric intake, more in accordance with his actual body needs.

Powers and Whipple have reported on two series of surgical patients and their response to early ambulation. These patients all got out of bed on their first or second postoperative day. Powers reported on 500 patients, and Whipple on approximately a thousand. The cases covered every field of surgery from thyroidectomy to all kinds of abdominal and pelvic operations.

Both of these investigators found that patients permitted early ambulation averaged five days' less hospitalization. In Power's series, they returned to their usual jobs four weeks earlier than the parallel group who stayed in bed the conventional length of time. Less sedation was required; postoperative complications were diminished; enemas were cut about 80 per cent, and no patient on early ambulation required catherization after he became ambulatory. This group of patients went on a regular diet the second or third day. I have seen the same results in my much smaller series of cases.

To my knowledge, Powers and Whipple have not mentioned the specific use of exercises for their patients, and I do not know whether they were employed. After all, ambulation is one form of exercise.

How Is a Bed Exercise Program to Be Accomplished?

A bed exercise program, just as any other exercise program, can be done incorrectly if certain basic principles are not understood. Fundamentally, this program must be based on (1) an absolute knowledge of the anatomy, physiology and innervation of the individual muscles involved; (2) the stress and strain to be put on those muscles in relation to associated and to antagonistic muscle groups, and (3) the sequence in which they are to be used to attain the best physiologic results. When these three factors are kept in mind, a proper exercise program can be established. The muscle reeducation must follow through certain muscle groups in the proper sequence, to apply the physiologic principles which have been proved throughout the years, through the concepts and results of that work which has been done in the field of physical education.

Muscle testing and muscle reeducation are primarily the knowledge and training of a physical therapist. Since only a certain group of specialists, like the neurologists, the neurosurgeons and the orthopedists, have occasion to use these tests frequently, many of them are accustomed to have and usually expect, a physical therapist to do this diagnostic work for them. The doctor in a usual routine practice, whether in medicine or surgery, has

the particular need to use these tests so rarely that on the occasion when he does need them he, too, will depend on the physical therapist.

The physical educator, with his excellent knowledge of kinesiology, has had no specific training in muscle reeducation. Corrective gymnastics are often thought to include this, but they actually do not, since corrective gymnastic exercises are meant to cover large muscle groups usually and not to require specific attention to true muscle reeducation or to the orientation of specific muscles. As was excellently stated in an editorial in the ARCHIVES OF PHYSICAL MEDICINE for December, 1945, "Persons trained in physical education only have made most of the studies relative to bodily mechanics. However, most if not all of these studies have been on apparently healthy individuals. Their studies of corrective exercises have been related largely to posture. . . . Therefore, persons trained in schools of physical education are not fitted in any sense to treat the sick and handicapped except to give exercises for the uninvolved parts or conditioning exercises to nearly normal patients."

It is my opinion that this misconception of actual training has permitted many poor exercises to be used on bed patients, exercises which are not only oor but often either useless or harmful or both.

At no time in a doctors' training is he given instruction in specific exercise work. There are no reasons why he should have this instruction included in his studies, with all the other medical details that he has to know and the duties that he himself has to learn to perform. The doctor definitely knows the results to be accomplished. The specific manner in which they can be accomplished he usually leaves up to the specialist in that field.

When no physical therapists are available, the doctors have often specified those definite results to be accomplished. They have been unable to instruct the patients specifically how to attain these results or to instruct other personnel serving those patients. Thus harm has no doubt been done at times, although it was unintentional.

The patient should have specific written instructions, just like any other prescription, so that he may continue the exercises through the day and on each day as indicated. They should progress through his convalescence to include more muscle groups, with an increased range of motion and with increasing strength. Therefore the establishment of correct bed exercises, like all other therapeutic exercises, must first be worked out by the physical therapists, with their specific knowledge of muscle tests and muscle reeducation. This does not mean, however, that such exercises are to be carried out only by the physical therapist. It would be ideal if a physical therapist were available to supervise such a program, but it is not absolutely necessary. Once the exercises are worked out, the nurses and other personnel may be trained to direct the program of exercises adequately.

As has been mentioned previously, relaxation is taught before exercises are started. Relaxation should be taught to all patients, whether they are to be put on an exercise regimen or not, because (1) from these "positions of election," the patient will be less tired, since he is under less stress and strain; (2) because of the fact that because he is relaxed, he will have less discomfort in relation to his particular illness; (3) deformities may be prevented. The deformities from an incorrect bed position may be temporary if he is a patient for only a short time; on the other hand, if he is to be a patient for a few weeks to several months, definite and permanent deformities can easily develop, and they can start very early in any illness.

An excellent place to start this instruction is with the feet. The patient has to stand on those feet and they have to be strong. The common hospital requirement that a perfectly made hospital bed must have the sheet drawn so tightly across the foot of the bed that it is smooth is a malicious misuse

of therapy. When a sheet is pulled tightly, the feet are immediately dragged down and held down in that position. Two mechanical defects immediately result:

1. The heel cord is shortened. After a patient is in bed any length of time a shortened heel cord makes it difficult for him even to touch his heel to the ground when he first starts to stand again. Too many women have already ruined their feet before their illness with the persistent use of high heels, and that present deformity should not be made worse. It is an interesting thing to note the number of men who will start walking on the tips of the toes also when they first get out of bed.

2. After the heel cord is shortened—no matter what the arguments may be regarding metatarsal and longitudinal arches of the feet—I believe it is pretty definitely accepted that plantar flexion of the feet, with the concomitant shortening of the achilles tendon, may be a very definite factor in the causation of flat feet.

3. When the sheet is pulled tightly, the toes may be bent backward at the same time. Dorsiflexion of the toes is never considered a good therapeutic procedure to emphasize, since dorsiflexion of the toes causes a subluxation of the metatarsal-phalangeal joints, to produce the deformity of hammertoe. This, with other factors, particularly a shortened achilles tendon, may result in a permanent pes cavus or clawfoot deformity.

The next joint to consider is the knee. Subluxation of the knee and a stretching of the hamstrings will result when the patient lies flat in bed with no support under the knee. This subluxation also causes a compensating hyperextension of the pelvis on the thigh, which causes lordosis. A very slight flexion of the knee—even only 3 to 5 degrees—is necessary to prevent this. The elevation need be no more than the thickness of a folded bath towel. Certainly the knees should not be kept continually in deep flexion if the patient is to be in bed for any length of time, yet in many illnesses this position is permitted and in consequence flexion deformities of both the knees and hips result.

At the same time that the proper position for the knees is being maintained, the quadricep muscles must be kept in tone. It is all right to have strong foot muscles to stand on, but if the quadriceps muscles are not strong, the knees will buckle when the patient first starts to stand.

That continuous hip flexion is to be avoided is obvious, but of the muscle groups involved in the hips the gluteus muscles are too often forgotten. The gluteal muscles, particularly the gluteus maximus, are the main muscles which keep the trunk erect on the hips. Permitting patients to lie day after day on their backs and never having them turn on their faces is a common, unfortunate and incorrect practice. Notice that I said "have them turn." A large majority of them can always turn on their faces at almost any time in their illness, but they must be encouraged and shown that they can do so and how to do so.

If the gluteal muscles are to be given rest and at the same time be given exercises, this can be accomplished in two ways: 1. The patient can learn to contract the gluteal muscles by pulling the buttocks together beneath him as he lies on his back. 2. Better still, he can be taught how to do so, when lying on his face. Face lying is important for all the abdominal and back muscles as well. The proper position of lying on the face—or prone lying—must be explained to the patient. There are few persons who know how to lie correctly in the prone position and be relaxed. They must have no pillow under their head but must lie with the bed flat and with their face against the sheet and turned to one side or the other. At the same time, they will find, when it is demonstrated, that bending one arm up toward

that side of the face and having the other arm straight down at the side will definitely relieve any stress and strain on back and neck muscles and will give them a chance to relax and rest all those muscles. The pillow that was under the patient's head should be put under the ankles in order that the feet do not drag on the bed in that position. Otherwise, the same plantar flexion of the feet, with the same deformities, can occur as occur when the patient is in the back lying position with a sheet pulled tightly across the feet.

Any person who has been in bed for twenty-four hours will notice an aching in his lower back. It is amazing how only a few hours of bed rest will bring on this aching. It is no doubt due to a relaxation and stretching of the lower back muscles as they are relaxed against the bed. It is bad enough on a hard bed. How much worse it is on an inner spring mattress, which offers no support whatsoever to the back muscles, in spite of all the advertisements to the contrary. When a small pillow, or even a bath blanket, is placed under the small of the back while the patient is lying on his back, or placed there at least from time to time, the counter pressure of that support will help to provide support to those back muscles and make the patient far less tired and certainly far more comfortable. To lie without a pillow under the head at least part of the time relaxes the neck and upper chest and back muscles also. Exercises are always done without a pillow.

When these things are all explained, the patient then can be instructed, first, in the art of relaxation and, second, in the actual doing of the specific exercises.

Relaxation

The "trick" to relaxation is to learn individually to relax each muscle group. The patient has to know consciously and consciously think through how each individual muscle group feels when it is contracted (or tense) and how it feels when it is relaxed.

The easiest place to start this instruction is with one hand. The hand is clenched and, then it is released. This is an easily executed exercise and one that is both easy to feel and easy to see and one that is easy consciously to think through. None of the procedures need be strenuous; they need be merely of a "conscious—or thinking through" nature. From one hand, it is easy to work up through the forearm to the upper arm or else to exercise each hand, then each forearm, and then each upper arm separately. The exercises for the arms are followed by those for the neck and face muscles and then by those for the muscles down the trunk and through each leg into the feet.

Face and neck muscles are the most difficult to relax and keep relaxed. Grimaces in front of a mirror are an excellent visual way in which to teach relaxation of these groups.

As the patient relaxes each group in turn, he must remain aware that that group remains relaxed as he goes on to the other groups in turn, so that finally his entire body is completely relaxed and the patient is well aware of it.

Rest and relaxation are a necessary part of healing. There is no rest without relaxation. Muscle activity builds up certain chemical changes in the body which cause the condition known as "fatigue." Rest restores this chemical condition to a proper balance. From a state of relaxation, the patient is able more easily to go on into sleep or, if he is refreshed, to revert to activity more quickly. Relaxation is advisable before any change—from one activity to another, or from activity to work, or from work to rest, or

from rest to sleep is made. Less sleeping medications are then required when sleep is indicated. When a patient is relaxed, he also will have less pain. The analgesics which he may still require will, when administered, take effect much more quickly and more completely.

When Are Exercises to Be Used?

Surgical Patients. — It is my belief that bed exercises may be instituted for practically every surgical patient within twenty-four hours after operation. It is better if the patient is instructed in relaxation and in exercises even before the operation if he is in physical or mental condition to be so instructed.

The postoperative elevation of temperature which is usually expected is no contraindication. As a matter of fact, I have observed fewer temperature rises in those patients who exercise than in those who do not. In fact, many of the patients in this series have had none.

On the first day after operation—perhaps the second—the exercises to be instituted start with only exercises for the feet, the quadriceps, the hands and the forearms and are of short range and duration. Then on the second and third days, while the range of motion of leg and arm exercises are increased and more muscles are put into use, pelvis tilting and abdominal breathing are started, even though there may be an abdominal incision. For patients with midline and with right or left rectus incisions, it is quite safe to start this early and with no fear, irrespective of whether the internal sutures are cotton or chromic gut or whether the skin closure is accomplished with cotton, chromic gut, silk or clips.

A delay of twenty-four hours—or to the fourth day—in starting abdominal exercises may be indicated for patients with upper abdominal incisions if they are extra long, or if the patient is heavy or if a gallbladder operation has been performed in the presence of jaundice.

Of the 75 or so surgical patients I observed, only 1 patient had a bad result. This man had had a persistent progressive jaundice for over four weeks before cholecystectomy was attempted. This had to be done. The postoperative course was uneventful. The clips had been removed about the sixth day, and the incision appeared to have healed by first intention. The jaundice, as expected, had decreased but little, when on the ninth day he eviscerated a small tag of omentum. The silk stay sutures were holding well. After a second closure his recovery was uneventful, although the abdominal exercises were deferred from the fourth to the sixth day the second time.

I do not believe that abdominal exercises could be blamed for the evisceration in this case, although I cannot say that they may not have contributed to the situation. Since this is the only case in which a closure broke down, and since in none of the other patients did even a hernia develop, I interject this as a warning, particularly when jaundice is involved.

The average patient with a gallbladder operation has done as well as the average patient with an appendectomy. Those patients with cholecystectomies who exercise are certainly more comfortable, and quickly so, than those who have not exercised. In my observations, gallbladder operations involve no more hazards than do appendectomies on this regimen. I grant that this may be due partly to the skill of the surgeons with whom I worked, since they are able to perform those operations as easily and safely as they do an appendectomy.

A long midline incision is no contraindication to exercise, even if the patient is heavy or if he has a pendulous abdomen, or if he has had an um-

bilical hernia which has been repaired or a diastasis recti—that is, a separation of the rectus muscles—which has been repaired at the time the incision is closed. A separation of the rectus muscles is often found in heavy persons or in those with poor muscle tone. It occurs frequently in women during pregnancy. When it occurs, the main support of the anterior abdominal wall is only the fascia underlying the rectus muscles. An umbilical hernia or any other hernia occurs of course when the fascia itself is weakened and separated and thus allows the underlying organs to protrude through that separation or split of the fascia.

As a matter of fact, pelvis tilting started early for all of this group of patients is of distinct value to the healing of a midline incision. While the exercise increases circulation and prevents stasis in this area, it is also of value to prevent further or future rupture or diastasis, because it is the one exercise which particularly strengthens the rectus muscles and at the same time does it without strain. Strong rectus muscles are absolutely necessary to maintain the anterior abdominal wall in proper tone to prevent ptosis and to prevent a separation of the bellies of the two rectus muscles.

Abdominal breathing exercises may have to be introduced cautiously for this group of patients if the abdomen is fat and tense but not pendulous. For the pendulous abdomen, they should be introduced as early as is pelvic tilting, as the exercise definitely increases tone—of which there is little or none in such an abdominal wall.

Medical Cases. — In medical cases, the time at which exercises are introduced will vary with the case.

In the study of primary atypical pneumonia made by the Army Air Forces, the exercise program was introduced as soon as a patient became afebrile, even though his sedimentation rate remained elevated. My colleagues and I have carried out the same regimen with equally good results. We think that we have had roentgen evidence that areas of consolidation disappeared more rapidly in these cases. They appear to do likewise even in cases with pulmonary infarction, in which exercises have also been started as soon as the patient was afebrile. As a matter of fact, temperature seems to be the best guide for all medical patients who have infections, irrespective of the sedimentation rate, particularly if the illness involves the chest.

For patients with cardiac decompensation, exercises of the feet and legs and of the hands and forearms have been instituted as soon as the patient was under control with digitalis or related drugs. When the compensation has been established and has remained for a few days, abdominal exercises are instituted.

Special breathing exercises will vary with the conditions of the lungs or with a cardiac condition, but for patients with asthma, exercises to teach expiration should be instituted at once. These are specific exercises which have no bearing on the general bed exercises now under discussion.

Patients with severe arthritis who were hospitalized for special treatment, or if they were semiambulant at home, were given very specific instructions, specialized to the individual case. The most important thing for all this group, was the teaching of relaxation followed by exercise to assist them to correct individual deformities without overexercising or without increasing the stiffness and pain associated with the arthritis.

The sequence of general exercises, then, is built up from day to day. The feet, the quadriceps, the hands and the forearms are exercised first. Exercises of these parts will cause no stress and strain to any other parts of the body, even as they increase general circulation and while they maintain local tone to the exercised parts.

Each day the range of motion and the strength and effort required to

do the exercises are built up in legs and arms, with as nearly equal a balance as possible between the upper and lower extremities. Those for the legs proceed to flexion exercises for the knees and hips, abduction and adduction of the hips and inward and outward rotation of the legs; and exercises are carried into the upper arm and continued until a complete range of motion may be carried through in the shoulder girdle.

Exercises in all these groups which can be done in side lying and face lying positions are instituted just as early as the patient can assume these positions himself with as little help as possible. It is a surprise to the patient himself—and I must confess that I too have been surprised at how soon a patient with an abdominal incision can lie comfortably on his abdomen. Unless the dressings have to be too bulky, many patients with such incisions are comfortable in this position at least by the fourth day.

In the prone position, pectoral stretching may be started very early unless the shoulder girdle, the chest or the neck are involved; care has to be taken to prevent any strain in this position or any increase in respiration or expansion of the chest wall itself.

Elevation of the trunk with hyperextension of the back from a prone lying position must be regulated carefully in relation to the abdomen, since this exercise causes a stretching of the anterior abdominal muscles, particularly the rectus muscles. For this reason, it is used late in most abdominal conditions, and then only with great caution (if it is used at all).

As stated previously, the abdominal exercises of pelvis tilting and abdominal breathing are started in the majority of cases on the second, or surely by the third, day. Later, pelvis tilting with head raising increases the strength of action of the rectus muscles.

The only exercise used for the lateral abdominal muscles is that one in which one leg is lifted directly across the other with the knee kept straight. It seems to me that it is the only lateral abdominal exercise which is safe to use. All the other exercises which call for trunk twisting and bending might cause undue stress and strain on abdominal incisions by the very nature of the exercise itself or by an overzealous patient or by overzealous instructors. The latter group of exercises have other specific uses but not in this type of program.

I believe that the exercises just outlined are completely safe in all conditions. Not only are they safe, but they are adequate. Further, if pelvis tilting is taught, first with the knees bent to a 45 degree angle and the degree of flexion of the knees progressively lessened until the legs are almost straight on the bed, it can be explained to the patient then that this position is the position of proper posture—that is, if he were to be "up ended" from the horizontal to the vertical position. Later, when he is up, correct posture is easily taught. When patients so taught stand for the first time, they stand and walk erectly. Nor do they appear to have the need to pat or hold any abdominal incisions or dressings which they may have.

Bicycling, straight leg raising and situps can all be very harmful to unconditioned muscles. They are excellent for healthy muscles, after the normal person has worked up to doing them by doing less severe exercises first. This group of exercises would not be used in any physical education class for normal persons until preliminary exersises had been done for several days. In addition, this group includes exersises for various muscle groups and large ones at that. As is generally known, the evaluation of the muscle groups used for these exercises is often misinterpreted or the exercise itself is performed incorrectly. Misinterpretation permits the wrong exercise prescription. Likewise, an exercise prescribed correctly but performed incorrectly causes equal harm. It seems to me, then, that these

exercises belong only in a seasoned physical education class in whose members the muscles are healthy and have been properly conditioned. Too often have I heard a surgeon say to the patient, "Start moving your legs, kick them up and start bicycling," and that has constituted the only exercise instructions.

Special exercises for fractures, all other orthopedic conditions, nerve injuries, poliomyelitis, hemiplegia, paraplegia, asthma, cardiac conditions and thoracic surgical conditions require special individual work by a trained physical therapist. These have no place in this current discussion of general bed exercises, although these patients need these exercises in addition to their own special ones.

Ambulation

I concur heartily in the observations made by Powers and Whipple regarding ambulation. Since this is not a universal practice as yet, it was not possible for all of the surgical patients in my own series to be allowed out of bed on the second day, since that decision is up to the surgeon. However, many were allowed up then and almost all of the others by the fourth day at least. I believe that the early institution of bed exercises was of as much value as early ambulation. I also believe that the two should be combined.

Results

My own observations are as follows:

1. Patients required little or no morphine after the first forty-eight hours. Some would request it occasionally after that at night, but even then its use was definitely decreased, as were the amounts of all other sedatives the patients always used to request. These patients never request sedatives after they leave the hospital either, a fairly common procedure with other patients.

2. There were far fewer complaints of "gas pains," sometimes none, and rarely any complaints of abdominal pain after the second day.

3. There was little or no nausea after the first two days. By the second day the patients usually requested food, and their appetites improved rapidly.

4. There was less need for catheterization, and none when the patients got up.

5. Postoperative cystitis occurred with less frequency. I should like to suggest that this is probably due to the bladder being distended less often when less catheterization is needed and, at the same time, to the earlier bathroom privileges and avoidance of a bed pan. Since 90 per cent of the women patients with cystitis have had cultures positive for bacillus coli and since almost 100 per cent of them used to have cystitis before early exercise and ambulation were introduced, I think that this may be enlightening.

6. When the patients first sat up on the edge of the bed (by the second day usually), they rarely complained of dizziness. When they sat up in a chair, they tired less quickly and usually asked to sit up much longer than usual. The first time the patients sat up, the usual time of fifteen to twenty minutes was increased to thirty to forty-five minutes at the patients' request, because they experienced no fatigue. After that, they requested to be allowed to sit up at more frequent intervals and for longer and longer periods of time.

7. Backaches were rarely mentioned by the patients.

8. Fewer enemas were required. Normal bowel movements were usually established within the week, if not by the fourth or fifth day.

9. When the patients took their first steps, there was no tingling in the feet; the knees did not buckle; the patients walked in a fairly erect position and required no support to walk across the room (although it is certainly unwise to take chances and not have an attendant the first time or so). Often with the first steps, they would stop, look around in surprise and say, "Why, my legs feel fine. I believe I could walk right out of here."

10. In addition to the marked lessening of the occurrence of cystitis, not one of these patients so exercised had other complications. No emboli occurred in this series. The complication mentiond before was the only one observed, and it cannot be entirely blamed, if blamed at all, on these exercises, even though they cannot be excluded. One medical patient was admitted to the hospital with a pulmonary infarct and carried on this regimen with good results. Two others had infarcts from chest conditions which were not surgical and received the same treatment.

11. The patient was usually ready to go home within five to eight days. He could always go by car unless it was a question of having to climb a flight of stairs on his arrival home. He was permitted to walk up and down stairs just as quickly as he himself felt strong enough, however.

12. Irrespective of the type of abdominal surgery, the patients were usually ready to go to work within a month. Several were ready for work within that time—only to be delayed by preexisting factory insurance rules, which set a certain number of weeks before each type of postoperative patient may be allowed to return to work, irrespective of how he feels.

One woman, aged 46, a teacher and school principal, with a complete hysterectomy and a perineal repair, returned to full time work in one month and two days. A second woman, age 56, who had had a coronary condition six months previously, and electrocardiographic proof of it before a cholecystectomy was done, returned to manage her dress shop in one month and went on a buying trip to New York in six weeks from the time of her operation.

While an accurate record has not been kept of the number of medical and surgical patients treated in this manner from January, 1944 to January, 1945, it is my opinion that the results have been uniformly good, even though lack of time prevented the keeping of statistical proof.

In addition to the observations listed, these things were definitely accomplished:

1. A lessening of days of hospital stay—an advantage both to the patient financially and to the hospital needing beds.

2. The earlier time that the patients could return to work, which again meant a financial gain to the patient.

3. The very decided improvement in the morale of the patient.

An explanation is made to the patient, even before he enters the hospital for surgical treatment, that the days are now past when he can expect to sit at home and "enjoy talking about his operation" for the next three to six months. He is told that, barring any complications, which can always occur but which are not expected to happen, he will be out of the hospital in approximately a week. He should be living a normal life within a month—certainly six weeks at the very latest; that when it is over and done that is all there is to it, and six weeks after the operation is over he is no longer to consider himself a sick man. Surprisingly, the old, worn-out remark, "Now let me tell you about my operation," is cheerfully relinquished. The patient is just as glad to forget as the staff are and I suspect, as are his friends. This healthy cheerful attitude on the patient's part is, of course, priceless. In my experience, it does not matter whether he is a medical or

surgical patient. Bed exercises have been found to be of definite value as a part of the medical treatment. Further, they decidedly become one integral part of that third phase of medicine, rehabilitation. Diagnosis and treatment are the first and second phases of medicine, but this third phase must be added if one is to return the patient to his community a self-sufficient, self-supporting citizen as soon as possible. When the concepts of rehabilitation are realized and used in all civilian and military hospitals, then the individual patient will be treated as a whole man. The full concept of rehabilitation includes not only the physical factors but the mental and educational factors as well. The educational program has two main premises: (1) to keep the mind alert, rather than allowing it to stagnate; (2) to give the patient the opportunity to increase his learning, and thus his earning power. These are ideals for which everyone must strive.

Rehabilitation is a matter of team work. It is not a matter of a doctor doing the mechanical and serious part of surgical and other procedures or of a doctor ordering a pill. It is not the physical therapist doing her work or the nurse doing hers or the occupational therapist doing hers, but it is the whole hospital team working in cooperation and mutual understanding to treat the patient as a whole man.

CONSERVATIVE TREATMENT OF CHRONIC MIDDLE EAR SUPPURATION

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and

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The running ear forms a large part of any otologic practice and presents a problem familiar to every general practitioner. Though the actual methods of treatment are numerous, it must be emphasized at the outset that complete and thorough toilet of the ear, carried out by an experienced otologist, is by far the most important single factor in successful treatment.

The perforation of the tympanic membrane must be visible and accessible before any local application is made to the ear. Any complications—such as granulations or polypi protruding through the perforation and wax, epithelial debris or otitis externa obstructing the external auditory meatus — must therefore receive treatment first, before any powder or solution is introduced, as any of these conditions may prevent a proper view of the drumhead. Granulations are touched with 20 per cent solution of silver nitrate until blanching is seen; polypi are removed by means of aural forceps, and any condition in the meatus is treated appropriately. The middle ear is finally cleared by eustachian catheterization and suction with a Siegel speculum. The ear is then thoroughly mopped with cotton wool on a Jobson-Horne (or similar) probe under direct vision until the meatus is completely free of discharge.

The subsequent management may be broadly subdivided into treatment by dry methods and treatment by wet methods. We feel that the vastly superior results of dry methods to those of wet methods justify our practice of treating all patients with chronic middle ear suppuration initially by insufflation of some form of powder. However, the striking results obtained by zinc ion

transfer in certain resistant cases would seem to warrant its inclusion in any scheme of treatment before one resorts to radical operation.

Dry Methods

In the dry methods of treatment various powders are applied by very gentle insufflation until a frosted-glass appearance is seen on the drumhead. This is the process of "frosting." The success or failure of any particular powder depends largely on its physical properties, the most important being the size of the particles and the hygroscopic and antiseptic qualities. A coarse powder may cause complicating otitis externa by the irritation of a meatus that is already inflamed by the presence of pus, while one that rapidly absorbs moisture may "cake" and the resulting concretions may obstruct drainage. The ideal powder, therefore, is one which is fine and nonhygroscopic, mildly antiseptic and yet nonirritating to the tissues of the ear.

Iodized Boric Acid. — Until recently we used a 1 per cent iodized boric acid powder as the initial medicament in every case of chronic suppurative otitis media, with a large proportion of successful results.

Preparation and Physical Properties: We quote the following information from an earlier publication.[1]

> The iodine powder first used was an American proprietary preparation, originated by Nathan Sulzberger, a New York chemist, about 1915, and was called by him "Iodosan." . . . The percentage of iodine in the powder varied from 10 to 0.75, but it was found more effective and much less irritating in the smaller percentages. . . . The powder readily dissolves in the discharges within forty-eight hours. . . . It is not a chemical compound of iodine. It is iodine in a finely divided condition distributed over boric acid as a carrier. It is prepared, according to the original direction, by adding an alcoholic solution of iodine to an alcoholic solution of boric acid; after this solution is freed of alcohol a brownish powder is obtained. The method employed by the present writer is simpler, less expensive and apparently equally effective: the appropriate quantity of resublimed iodine (according to percentage) is broken down with a few drops of spiritus vini rectificatus, and the fine boric powder gradually added. . . . Nascent iodine apparently gets into the furthest corners of the affected middle-ear.

Results: "The present writer has found in the past three years that 90 per cent of cases of chronic middle-ear suppuration—with healthy noses and throats — have been cleared up by this method carefully applied. . . . There have been a number of recurrences, which have, however, again cleared up after further treatment."[1] In one series of 30 cases, we noted recurrence in 3 (10 per cent), with otitis externa in 6 (20 per cent).[2] We have, however, recently obtained even more encouraging results from the use of two new powders, sulfathiazole ascorbate and sodium penicillin-sulfathiazole.

Sulfathiozole Ascorbate. — Ruskin,[3] in the United States of America, recorded the results obtained in 8 cases of chronic suppurative otitis media by use of a compound of sulfathiazole and vitamin C; in 6 of the cases the method of frosting was used. The sulfathiazole ascorbate is an equimolecular mixture of amorphous sulfathiazole and ascorbic acid and forms an extremely fine powder.

Results: We have recorded results in a series of 18 consecutive and unselected cases in which this method of treatment was used. The longest period of observation was one hundred and sixty-one days and the shortest was seventy-two days. The powder was used for all patients seen in the ear, nose and throat department of the military hospital, Gibraltar, during

1. Stevenson, R. Scott: Recent Advances in Laryngology and Otology, London, J. & A. Churchill, Ltd., 1935.
2. Stevenson, R. Scott, and Ballantyne, J. Chalmers: The Conservative Treatment of Chronic Suppurative Otitis Media, J. Laryn. & Otol. 60:166 (April) 1945.
3. Ruskin, S. L.: Vitamin C—Sulfonamide Compounds in Healing of Wounds: Use of Sulfanilamide Ascorbate in Treatment of Chronic Suppuration of Wound After Radical Mastoidectomy, Arch. Otolaryng. 40:115 (Aug.) 1944.

the eighty-nine days between the first and last cases; among the patients were several who had failed to respond to other powders. Although the number of cases is small, the results were so encouraging that we continued to use the powder; on the basis of our total results we believe that sulfathiazole is, so far, the most satisfactory powder for use in routine outpatient practice.

Results Obtained by Dry Methods of Treatment.

Powder	Number of Cases	Number of Applications Total	Number of Applications Average	Days of Treatment Total	Days of Treatment Average	Recurrences No.	Recurrences %	Otitis Externa No.	Otitis Externa %	Perforat'n Healed No.	Perforat'n Healed %
Sulfathiazole ascorbate	18	34	2	52	3	0	0	0	0	8	44.4
Sodium penicillin-sulfathiazole	14	34	2½	49	3½	4	28	1	7	4	28.6
Iodized boric acid (1%)	30	119	4	395	13	3	10	6	20	No record	

In the table our results are summarized and compared with those obtained by the use of 1 per cent iodized boric acid powder (30 cases) and sodium penicillin-sulfathiazole (14 cases). In the 18 cases in which this powder was used, an average of two applications over a period of three days produced a dry ear. There were no recurrences and no instances of otitis externa. In 8 cases (44.4 per cent) there was a healed perforation at the time of final examination, one hundred and sixty-one days after treatment with sulfathiazole ascorbate was initiated; in 1 of these cases there had been intermittent discharge for twenty-six years.

Sodium Penicillin-Sulfathiazole. — Preparation and Physical Properties: The powder is prepared by adding 3,500 Oxford units of sodium penicillin (supplied sterile by the pathologic laboratory) to 7 Gm. of an amorphous sulfathiazole powder (already sterilized by autoclaving). The compound powder therefore contains 500 units of sodium penicillin per gram of sulfathiazole. Sodium penicillin is known to be more hygroscopic than calcium penicillin and is therefore less stable. The penicillin content has been found to remain effective for only fourteen days at room temperature.

Results: In 14 recorded cases[2] we found that an average of two and one-half applications over a period of three and one-half days was necessary before a dry ear was obtained; there was recurrence in 4 cases, and in 1 the recurrence was complicated by otitis externa (after swimming). The perforation was healed in 28.6 per cent of cases. When these results are compared with those obtained by use of the other powders, they appear at first glance inferior. The lower values, however, can be readily explained by the instability of the penicillin content. In each of the first 7 cases a dry ear was obtained by one application of the powder; the ears remained dry until the date of the last examination (two months later), and in 2 cases the perforations had healed by this time. From this point onward (after the powder had been in use for fourteen days) there was a sudden rise in both the number of applications and the duration of the treatment required. All the recurrences took place in the second group of 7 cases. We feel, therefore, that better results than we have yet obtained with any powder may be expected from a more stable penicillin compound. An increased stability has been claimed for a compound of calcium penicillin and sulfamethazine (5,000 units per gram,[4]) but we have not been able as yet to obtain the powder for trial.

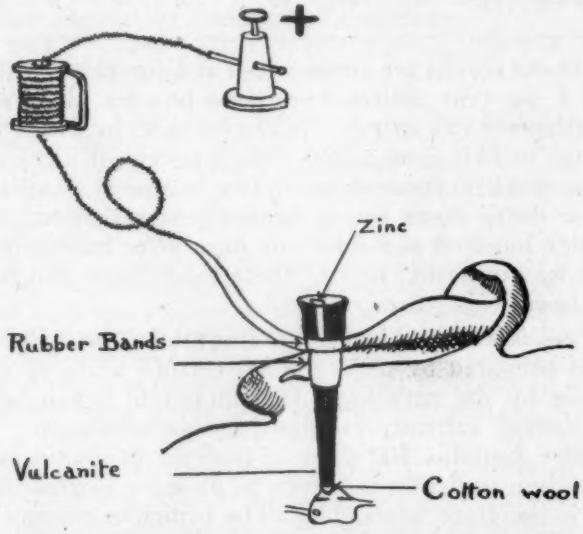
4. Chemotherapy in Brain Wounds and Meningitis, Army Medical Department Bulletin, Supplement No. 20, March, 1945.

Wet Methods

The method of ionization was introduced by Leduc and is based on the principle that by bringing active zinc ions into contact with the bacteria that flourish in, and keep up the aural discharge, a solution of zinc sulphate weak enough to be completely nonirritating to the living tissues will act as an effective germicide. Once the bacteria are destroyed, the discharge ceases and the tissues recover.[1]

Zinc Ion Transfer. — Principle: According to Friel,[5] the effect of zinc ion transfer is primarily chemical—the zinc ion combining with a portion of the albumin molecule in the tissues—and secondarily physical—the insolubility of the new compound causes the formation of a white resistant coagulum.

Technic: The preliminary toilet of the ear must be thoroughly carried out as previously described for treatment by dry methods and the ear finally syringed with a 1 per cent solution of zinc sulfate. Ion transfer is carried out by introducing the positive electrode into the meatus and protecting the skin from the zinc wire by a vulcanite speculum. The electrode is in contact



Technic of zinc ion transfer (after Friel). The skin of the external auditory meatus is protected by a vulcanite speculum, and the electrode is in contact with a zinc sulfate solution which fills the tympanic cavity.

with the zinc sulfate solution, which has been instilled into the ear so as to reach the tympanic cavity. The perforation must be large enough to allow the fluid to pass easily into the middle ear. If it is very small, the fluid must be introduced directly into the typanic cavity by means of a fine cannula after the mucous membrane has been shrunk with a solution of cocaine and epinephrine. The strength of current must be regulated carefully and slowly, particularly in reducing the current at the end of treatment, as otherwise giddiness and vomiting may occur. Friel usually applies 3 milliamperes for ten minutes. If this amount produces pain, 2 milliamperes may be given for fifteen minutes or, for extremely sensitive patients, 1 milliampere for thirty minutes. Four or five treaments at weekly intervals are usually sufficient to sterilize the affected area completely. We usually give 2 milliamperes for fifteen minutes three times a week. Six treatments are given initially, though as many as twelve may be required. When sepsis is in an inaccessible position, it should be made accessible whenever possible—for example, in attic disease the outer attic wall should be destroyed—before ion transfer is begun.

5. Friel, A. R.: Notes on Chronic Otorrhoea with Especial Reference to the Use of Zinc Ionization in Selected Cases. Stonebridge, Bristol, England, John Wright & Sons, Ltd., 1929.

Results: Many conflicting reports have been published regarding the efficacy of zinc ion transfer in treatment of chronic suppurative otitis media, but no author can claim results that equal those obtained by dry methods. In Friel's first paper on the subject,[6] cure was reported to have been obtained in 54 per cent of 99 cases; in a later series[7] cure was claimed in 50 per cent of 264 cases. Young,[8] in 1923, obtained cure in 50 per cent of 25 unselected cases, and Jobson,[9] a year later reported cure in 60 per cent of 45 cases. Probably the most reliable figures are those of McLaggan,[10] who obtained dry ears in 52.8 per cent of a large series of cases (1,601); there was recurrence in 20.8 per cent of these, but clearing almost invariably occurred after a second treatment. Between 50 and 60 per cent would appear to be the general value, and, though these results are distinctly inferior to those obtained by dry methods, we have found this method very successful in certain cases of resistant otitis media that we have failed to cure with powders and we strongly advocate its use in such cases before conservative treatment is abandoned.

Summary and Conclusions

In this paper we have recorded detailed methods of treatment—both dry and wet—of chronic middle ear suppuration. We have tried to emphasize the extreme importance of complete and thorough toilet of the ear before any local treatment is begun. Aural granulations and polypi must be treated at the outset, and the perforation must be visible and accessible.

We use dry methods initially in all cases; in most cases in which response to dry methods is good it occurs quickly. Therefore we suggest that dry methods be abandoned in favor of zinc ion transfer in any case in which there is still an active discharge after one month of regular and careful treatment with powders. As many as twelve applications of ion transfer (three a week may be required.

If the ear is still discharging after this treatment has been completed, effort must be made to eradicate sepsis in the neighboring organs—chronic rhinitis or sinusitis in the nose, adenoid hypertrophy in the nasopharynx and dental sepsis or infected tonsils in the mouth or oropharynx. After careful attention to these primary conditions, the treatment routine outlined may be repeated with benefit. Then, and only then, should conservative treatment give way to radical surgical measures.

Banham[11] has recorded the results of treatment by various powders in 200 consecutive cases; he concluded that "of the 200 patients treated conservatively, I consider a minimum of 18 . . . required some form of operative treatment." But dry methods only were employed in his cases, and even this low figure would seem too high.

In a series of 195 cases, we have found it necessary to submit only 3 patients to surgical measures after a combination of the dry and wet methods of conservative treatment.

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6. Friel, A. R.: Treatment of Chronic Otorrhoea by Zinc Ionization, Lancet 2:345 (Aug. 14) 1920.
7. Friel, A. R.: Zinc Ionization in Chronic Otorrhoea, Brit. M. J. 2:42 (July 8) 1922.
8. Young, S.: Treatment of Chronic Middle-Ear Suppuration by Electric Ionization, J. Laryng. & Otol. 38:245 (May) 1923.
9. Jobson, T. B.: Suppurative Otitis Media Treated by Zinc Ionization, Brit. M. J. 1:371 (March 1) 1924.
10. Treatment of Middle-Ear Suppuration by Ionization, Lancet 1:975 (May 11) 1929.
11. Banham, T. M.: The Conservative Treatment of Chronic Suppurative Otitis Media in Adults, J. Laryng. & Otol. 59:117 (April) 1944.

PHYSICAL RECONDITIONING OF PARAPLEGIC PATIENTS

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Medical Aspect

Patients with spinal cord injuries are notably difficult to treat and at one time were said to have a poor prognosis. However, with new drugs and modern methods of approaching the problem the outlook can be much brighter for a useful independent life, even though the spinal cord is severed.

When the paraplegic patients began to arrive from overseas, many were emaciated, weak and debilitated by urinary infection, bedsores, pain and poor nutrition caused by loss of body proteins through bedsores and urine. In the first six to nine months of their stay at Newton D. Baker General Hospital the main problem was to keep them alive. This was done by frequent blood transfusions, frequent feeding of protein-rich food, surgical closure of bed sores and combating the urinary infections by penicillin and streptomycin and increased fluid intake.

The patients hardest to treat were those with cord injuries of a high level. Those who had cord damage at the level of the sixth and seventh cervical vertebrae had partly paralyzed hands and had to be fed by attendants. Patients with cord injuries at the second to the sixth thoracic vertebra also required special care because of lack of muscle power and sensation from the midchest region downward. However, injuries in the lumbar and sacral regions responded more promptly to treatment, as more muscles were under voluntary control. Injuries of the sacral region only involve the cauda equina or lower part of the cord, which contains no nerve cells but only their prolongation, and can be classed as a peripheral nerve injury. Patients with such injuries were soon able to walk with a foot drop and improved faster than the rest.

The need for physical exercise to salvage the remaining muscle groups became evident as soon as the patient was the least bit improved. In the first place, exercise was necessary to improve the circulation and respiration of the bedfast patient. Appetite had to be stimulated, dormant muscle groups aroused and the patient's mind taken off his pains and problems. Most important of all, exercise was needed to check the decalcification of bones due to disuse, as many patients (10 per cent) began to form stones in their kidneys while all formed calculi in their bladders due to excessive excretion of bone calcium in the urine. The future of the patient was at stake, not only from the physical but from the mental standpoint as well, for the patient anticipated walking sometime again. For that, strength in the arms and shoulders was necessary. Even the exertion of lifting himself up on his trapeze bar hung from the bed frame required effort, and more muscle power was needed to have the patient swing himself up and out of bed.

Physical reconditioning of all paraplegic patients was started eventually, as soon as they were physically able to move their arms; progressive methods were used to build up their shoulder girdle muscles. This paid big dividends in the generally improved physical and mental tone of each patient and served to reduce the number of complications. For instance, increased thirst after exercise made the forcing of fluids easier, and the urinary infections im-

proved. Upright position and wheelchair, then later crutches and brace walking, allowed better kidney drainage, and no new kidney stones were formed when exercise had been established. The morale improved, and more patients were eager to help themselves.

Physical Aspect

In physical reconditioning the psychologic approach is direct and sincere. Each man is made aware of the extent of his injury. He is urged to devote all his time and energies to becoming physically and mentally devoid of the need for assistance in facing the future.

The primary aim of physical reconditioning is to superdevelop any remaining innervated muscles to such an extent as to make the paraplegic person physically independent of assistance in ambulation and personal hygiene. In most cases the shoulder girdle and the arms become the essential salvaged structures. Rigorous exercise is especially devoted to these parts, as they become the only power factors of locomotion with crutches and braces.

To strengthen these parts of the body free arm calisthenics are first given in bed interspersed with deep breathing to condition the lungs. Gradually weights (dumbbells) are introduced; they range from 3 to 40 pounds each. Exercises of a resistive nature with weights and employing an accumulative count motivate the patient to increase the size of his atrophied musculature. Exercises with 30 to 75 pound bar bells are also given in bed. Rubber tension cables also provide another type of resistive apparatus which can be successfully employed in physically developing the bed patient.

Group calisthenics on a thick wrestling mat are strictly adhered to. It is here that the patient is given the opportunity to function as a part of a team. Free arm exercise are followed by sit-ups which induce the men to tone abdominal muscles above the level of injury. This is practiced until a patient can attain the sitting position without the aid of a weight to provide momentum. Crawling on all fours is taught and practiced to make a patient independent of a restrictive area. He crawls to the type of apparatus he desires to use. In the event of an emergency, crawling will also enable a paraplegic person to move out of the danger area. Push-ups from the mat are repeated frequently to develop the triceps muscles, so important in crutch walking. Heavy bar bell exercises are given in increasingly greater amounts as the condition of the patient improves. It is these overload principles which bring about marked increase of muscle size in a relatively short time, as shown in figure 1.

Fig. 1. — Bar bell exercise

Several crutch technics are taught and demonstrated. The patient soon applies the technic adapted to the extent of his injury. Distances traversed

are timed, and speed is considered secondary to proper form and safety in ambulation.

In coordinating physical exercises with sports, volley ball with a low net and regulation volley ball or volley bladder stimulates another form of physical outlet. To add a touch of comedy, a punching bag bladder can also be used, as its direction of flight can never be judged.

Bowling from fixed wheel chairs on a regular bowling alley becomes a must for paraplegic patients, as shown in figure 2. A score board is maintained. It is not exceptional to see scores of 120 and upward from the paraplegics bowling league.

A speed and slow punching bag are installed at the proper height. Many

Fig. 2. — Bowling from fixed wheelchairs

patients have actually become adept in "making the bag talk."

Passing the football, basketball, medicine ball, soft ball and archery can be performed at moderate distances, as shown in figure 3.

Fig. 3. — Archery for a paraplegic patient

Inactive and atrophied limbs of a paraplegic patient are bouyant, and he is capable of making progress in the water. Water wings should be worn by the paraplegic person and a instructor should be present at all times during any water therapy.

The total of 80 paraplegic patients have been treated at this hospital with an average of 50 participating in the reconditioning exercises each day.

Because of the nature of the injury personal hygiene becomes difficult to perform. Patients must be made to realize that they must do as much for themselves as possible. Washing, shaving, showering, giving themselves enemas with equipment especially constructed, and inserting catheters can be accomplished with practice and repeated attempts. It is found that the men who learn to perform these functions for themselves have more time to devote to personal hobbies and vocational training. Consequently, time does not drag their hands.

Physical progress charts, like those indicated, figures 4 and 5, provide incentive to increase physical measurements and efficiency. If a patient's measurements fluctuate after operations, a chart and graph becomes a visible

NAME Patient No. 12 **RANK** Sgt.

INJURY Transverse Myelitis At Thoracic 8 Vertebra

DATE	NECK	CHEST	BICEPS	FOREARM	DYNOM.	WEIGHT	MISC.
10 Aug 45	14½	N. 36½ E. 37½	L. 12½ R. 12½	R. 12 L. 10½	R. 92 L. 94	135	
10 Sep 45	14'	N. 37 E. 38½	L. 12½ R. 12½	R. 10 L. 10	R. 92 L. 94	139	
10 Oct 45	14½	N. 38 E. 39	R. 12 L. 12	R. 10½ L. 10½	R. 100 L. 100	138	
10 Nov 45	14 3/4	N. 38¼ E. 39 3/4	R. 11½ L. 11½	R. 10 L. 10	R. 10c L. 110	139	Chills Fever 106
10 Dec 45	13 3/4	N. 39 E. 39 3/4	R. 12½ L. 12 3/4	R. 9½ L. 10½	R. 10b L. 112	140	Chills Fever 108
10 Jan 46	14	N. 39 E. 39 3/4	R. 12 3/4 L. 13	R. 10 ½ L. 10½	R. 110 L. 108	14?	
10 Feb 46	14?	N. 38½ E. 39 3/4	R. 14 L. 14	R. 10 3/4 L. 10½	R. 112 L. 109	147	
10 Mar 46	14 3/4	N. 38 E. 40	R. 14½ L. 14½	R. 11 L. 10 3/4	R. 112 L. 110	153	
10 Apr 46	15	N. 38½ E. 40½	R. 14½ L. 14½	R. 11½ L. 11	R. 114 L. 106	153	

Fig. 4. — Physical progress chart, upper extremities

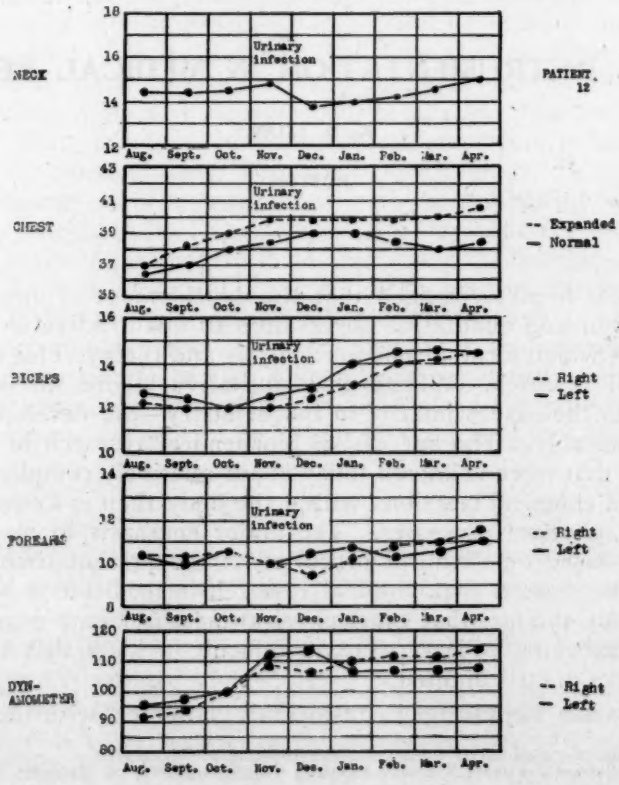

Fig. 5. — Physical progress graphs, upper extremities

record. Charts and graphs, indicate the amount of muscle atrophy, post-operative complications and lax furloughs.

Measurements of the upper and lower extremities are taken monthly. Although the lower extremities do not function normally, the patient is interested to observe improvement in the range of motion when contractures are prevalent. Contractures frequently are noted in the hips, knees and ankles. Records, charts and graphs are maintained as a permanent part of the patient's medical and physical history.

The correlation of medical and physical care of paraplegic patients proves that:

(1) Muscle tone becomes more permanent; (2) shoulder girdle and upper arm strength develops to a high peak; (3) physical efficiency is increased to ambulatory phases; (4) natural fatigue is induced; (5) appetite is increased; (6) sedatives for sleep and rest are necessary in greatly diminished amount and in time not required; (7) water intake becomes greater and thereby the tendency for urinary infections and calculi formations of the kidneys and bladder is decreased; (8) physical independence in ambulation creates a brighter mental outlook.

Acknowledgment is given to Colonel E. L. Cook, Medical Corps, Army of the United States, Commanding Officer, Newton D. Baker General Hospital, Martinsburg, W. Va., for unstinted interest and rapid aid in obtaining necessary equipment.

Acknowledgment is given to Sergeant Willard Braithwaite and Sergeant Royal F. Morris, Physical Instructors, for sincere and devoted effort directed toward the physical reconditioning of paraplegic patients. Appreciation is extended to Private First Class Erwin Lewis for maintaining the charts and graphs.

PHYSICAL INSTRUMENTATION IN MEDICAL RESEARCH *

K. S. LION

BOSTON

I

It has long been recognized that the development of any science goes from empiricism and qualitative observation to quantitative observation and measurements which form a basis for analysis and theory. This is particularly so in medical research. Whenever quantitative studies in medicine were possible—as is the case primarily in biochemistry—the development has advanced considerably. The success of biochemical research in medicine has been so great that more is known today about relatively complicated chemical structures and chemical reactions within the body than is known about relatively simple physical processes. The major emphasis in medical practice is, therefore, based on chemical processes at the present time.

One of the reasons that physical research in medicine is somewhat lagging is certainly the fact that exact physical measurements were not possible in many instances or at least were so difficult or slow that their practical application was greatly limited.

This situation has changed considerably, however, with the introduction

* From the department of biology, Massachusetts Institute of Technology.

* Read at the Eastern Sectional Meeting, American Congress of Physical Medicine, Washington, D. C., April 13, 1946.

of physical technics and methods created recently. The development of electronics in particular permits the measuring and recording of natural phenomena within a fraction of a microsecond and with almost no disturbing influence upon the system under investigation. Not only can electrical phenomena of biologic processes be measured by electronic means, but also mechanical ones, like pressure, energy, stress and flow rate, or physicochemical ones, like pH, diffusion, concentrations and many more.

Although these methods are known to the physicist and the electronics expert, it seems very difficult to apply them directly to medical research or to the development of medical instrumentation. The complexity of the problems requires the collaboration of both the medical research worker and the physicist, but even in the few cases in which this collaboration was possible the result was not always too satisfactory. The reason for this is twofold: first, the physical approach to many problems is different from the more phenomenologic inductive approach of many biologists and, second, the physical methods for research are so advanced that the medical research worker has frequently little comprehension of the new possibilities of research. It seems, therefore, that only through an appropriate training of both, the physician and the physicist, it may become possible to overcome the aforesaid difficulties and to lay the foundation for a basic and creative research work.

The need for a training of graduates of the biological fields in the engineering sciences has long been recognized in the United States and abroad. In this country it was primarily V. Bush and K. T. Compton,[1] who established the Laboratory of Biological Engineering at the Massachusetts Institute of Technology, while in Europe work of this sort was done mostly in the Kaiser Wilhelm institutes at Frankfort and Heidelberg and in some Russian institutes. The significance of the field of instrumentation for any kind of research is almost generally acknowledged in most universities or research institutes.[2] Lately, the Baruch Committee on Physical Medicine has taken deciding steps towards the introduction of the field of instrumentation in medicine and medical research, and means have been made available for the installation of courses in medical instrumentation in the department of biology at the Massachusetts Institute of Technology.[3]

The importance of instrumentation in physical medicine is too obvious to need further explanation. One can readily say that the development of the theoretic basis of physical medicine is largely a question of biophysical research and of the development of the necessary instrumentation for it. But even other branches of medicine and allied sciences, such as physiology, internal medicine, radiology and psychiatry, depend in their development upon the further advancements in the field of medical instrumentation. It is fortunate that also some industries have recognized the potentialities of an academic laboratory devoted to teaching, research and development of this field.

II

Perhaps it is necessary to explain the term instrumentation, particularly since the word itself is somewhat misleading. Other expressions for it have

1. (*a*) Compton, K. T., and Bunker, J. W. M.: The Genesis of a Curriculum in Biological Engineering, Scient. Monthly **48**:5 (Jan.) 1939. (*b*) Bush, V.: The Case for Biological Engineering, Scientists Face the World of 1942, Rutgers University Press, 1942. (*c*) Schmitt, F. O.: Physical Biology and Biological Engineering, Chronica Botanica **7**, 8:371, 1943.

2. (*a*) Klopsteg, P. E.: Increasing the Productivity of Research, Science **101**, 2632:569, 1945. (*b*) Instruments, Special Issue, Proceedings of the Conference on Instrumentation and the University **18**: 11, 1946.

3. (*a*) Report of the Baruch Committee on Physical Medicine, April, 1944. (*b*) Krusen, F. H.: The Future of Electronics and Electrical Instrumentation as Related to Medicine, J. A. Am. M. Coll. **3**: 8 (May) 1946; (*c*) Lion, K. S.: Technology and Medicine, Technology Rev. **48**:232, 1946; Arch. Phys. Med. **27**:279, 1946.

been suggested, such as instrumentology (Klopsteg), methodics and methodology. The latter, known as a philosophical term but not yet generally accepted in natural sciences, comes perhaps closest to the true concept of instrumentation, signifying "the science of the research methods." This word, therefore, places the emphasis correctly upon the method and the principle instead of the instrument. That is important, since instrumentation has been confounded, occasionally, with the expression "gadgeteering." The popular concept of gadgeteering signifies a shift of interest from the scientific problem and its solution to the instrument with which the solution is to be found but without consideration of the general principles involved in this instrument. Instrumentation, in contrast to it, is the science which deals with the principles of the instrument or the method. To illustrate this difference: It is the object of instrumentation to determine the operation characteristics of a vacuum system, or the methods of measuring the vacuum, their accuracy and how they are affected by the composition of the gas content. All these questions are of general significance for every vacuum system. If the work, however, deals with a device which gives a signal when a certain pressure is reached or automatically changes a number of positions of stopcocks or switches, one would call it gadgeteering, since the problem is not of a scientific, generally valid, aspect.

Instrumentation, as such, is an auxiliary science in medicine, in about the same way as mathematics is an auxiliary science for many physics applications, and like mathematics it influences frequently the character of the research work. The purpose of an instrument is, in general, to determine a physical magnitude quantitatively. The correct use of an instrument forces the research worker, therefore, to express his problems in such physical, i. e., fundamental, magnitudes. This is of importance, since the limitations to few, but usefully chosen, magnitudes has certainly contributed to the rapid development of the physical sciences. There is, therefore, reason to believe that the introduction of a similar method in medical research will prove equally efficient. A correct application of instrumentation will certainly also help to eliminate the misuse of instruments and the unjustified, almost superstitious belief in "meter readings" which can sometimes be found.

III

The teaching of general and medical instrumentation might seem a difficult task. The field is very heterogeneous and infinitely wide, while it is an essential characteristic of any established science that it can be taught in the form of a finite, logically built up, scheme. This is, however, possible because all instruments, in particular the electric ones, are composed of a relatively small number of elements, such as impedances, meters, amplifiers, etc. In concentrating upon these elements of instrumentation one can build up a logically grouped academic course that can be taught with the necessary completeness and without the danger of superficiality. The teaching of these elements is also of particular practical value. It enables the research worker to build with them, in a creative way, new instruments for the medical problem under investigation.

The course in medical instrumentation at the Massachusetts Institute of Technology, previously mentioned, tries to follow these lines. The course has been described by H. J. Bearzy;[4] its outline is given in the table. The material is selected with an emphasis on electric and electronic instrumentation which is particularly promising in medical research. Some of the more complex mechanical and thermal measurements are introduced as applications

4. Bearzy, H. J.: A Report on the Program of Training and Research in Physics and Technology Conducted at the Massachusetts Institute of Technology, Arch. Phys. Med. 27:274, 1946.

Program of the Course in Elements of Medical Instrumentation.

1. Linear circuit elements
   Resistance, capacitance, inductance, impedance
2. Nonlinear circuit elements
3. Circuits
4. Meters
5. Voltage and current sources
6. Vacuum tubes
7. Amplifiers
8. Elements of acoustical instrumentation
9. Elements of optical instrumentation

of electronics. Acoustical and optical instrumentation, however, are treated as special subjects. It is frequently believed that acoustic instrumentation is of interest only to the otologist. This is, however, not so. Sound and supersonics are forms of energy which are now, and will be in the future, increasingly valuable for diagnosis and therapy. Acoustics is treated therefore under this more general point of view. The section of optics is started under the same viewpoint. Emphasis is given not to geometric optics, lens systems, etc., but rather to measurement of intensity and wavelength, to ultraviolet and infra-red technic.

The figures 1 to 5 show some of the material and instruments used in the course. To demonstrate the principle of instrumentation elements, it was necessary to develop a series of new teaching models which are used in the laboratory work.[5] Figure 1 is an example of such a model, illustrating

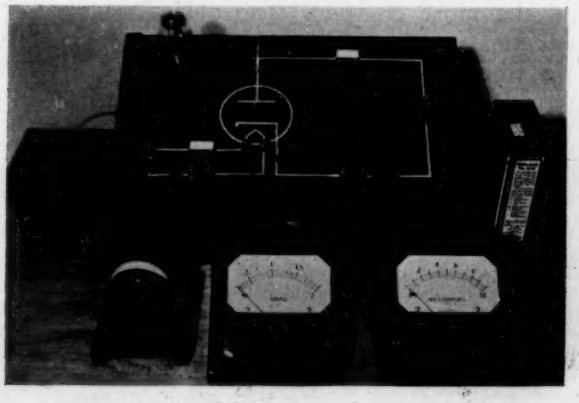

Fig. 1. — Instrumentation panel of the diode. The panel is connected with outside meters and voltage sources so that all measurements can be made on this panel. The tube to be investigated is placed in a socket at the upper left of the panel.

the function of a diode as the simplest representative of an electronic tube. A drawing on the front side of a pressboard panel indicates schematically the tube with all parts, together with the wiring diagram, while the real tube which is to be investigated is placed in a socket at the upper left of the panel. All connections to this tube are as indicated on the front side. One can clearly distinguish the filament circuit on the left lower side, connected to a battery, a variable resistor and a voltmeter, and the plate circuit at the right side, connected to a battery and a milliameter which measures the electronic current passing through the tube. Connections to the painted diagram are made by plugs and jacks. While the real connection would show a confusing mass of wires (particularly if the wiring is made by an untrained worker), the wiring diagram on the front side of the panel

5. These will be described in the *American Journal of Physics.*

is clear and permits the student to comprehend the circuit easily.

The next step of electronics is comprised of the more complicated vacuum tubes, the triode and the pentode, as illustrated in figure 2. The basic am-

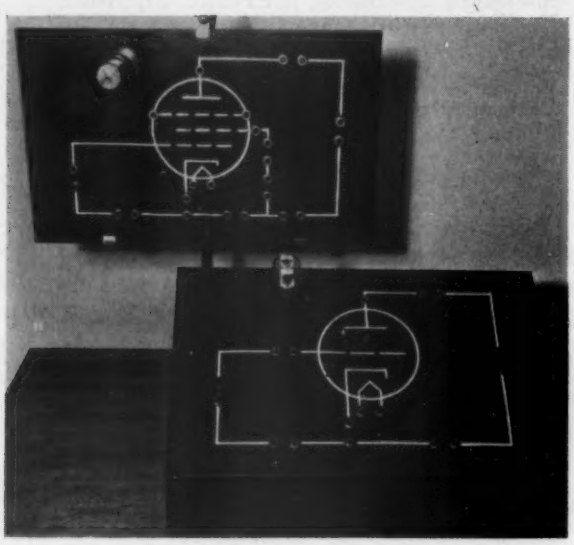

Fig. 2. — The triode and the pentode. Experimental model panels for measurement of the characteristic properties of these tubes.

plifier types and the more complex electronic circuits are developed in a similar way. All measurements are made on these panels and are supplemented by measurements with the older classic types of laboratory set-ups and with commercial instruments. Figure 3 shows a part of the instruments

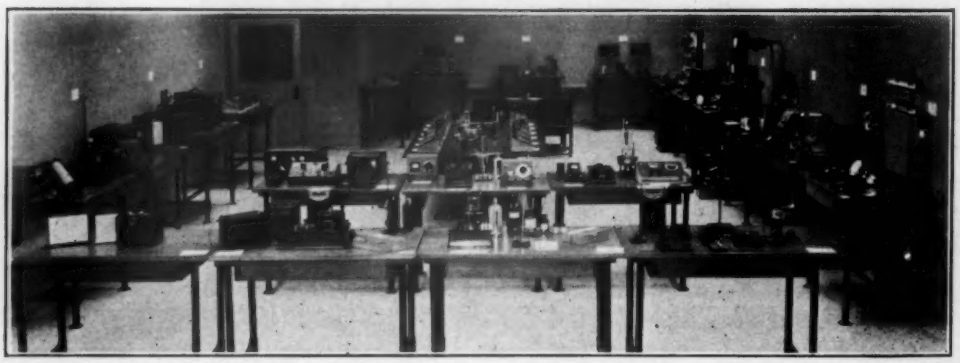

Fig. 3. — Part of the electric and electronic instruments used in the course of medical instrumentation at Massachusetts Institute of Technology.

used in the course, and figure 4, a typical working place in the laboratory where more advanced work on a model of a semicommercial style is being done.

The experience of the first courses has shown that the physician who takes this course frequently does not have a substantial knowledge of physics. The premedical physics training—which should form a basis for such a course—is usually forgotten after several years. The modification of the course in the described way is, under such conditions, a substantial help for a better understanding of the physical instruments and their underlying principles.

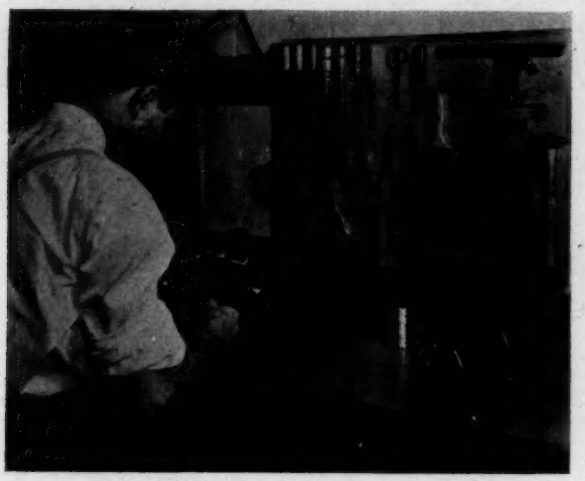

Fig. 4. — Typical working place in the laboratory of medical instrumentation.

IV

No description of the purpose and the value of instrumentation would be complete without mention of another result which is expected and which has actually been observed. It has been mentioned before that instrumentation can, to some extent, influence the ways in which research can be done. It is interesting to observe that successful instrumentation is never done in a cut-and-try way. It requires almost always, a predesigning, or at least an estimate of the expected order of magnitudes to be measured. The application of a similar attitude seems particularly promising in medical research. The aim of former research used to be the "unbiased" collection and observation of natural phenomena. A great number of research programs can be set up in such a way, but the efficiency of such research is rather limited, particularly with more complicated problems. The mere observation is frequently unsatisfactory. It leads to a plurality of single phenomena that can never be mastered by one man's brain. Only by classification and grouping according to theoretic considerations is it possible to obtain a unit of concepts that can be embraced by a single observer, and can lead to practical applications of general significance. The process of modern research is, therefore, different. It is usually initiated with a theoretic consideration which follows deductively from known facts. This hypothesis is then proved by experiments. It is quite obvious that under such conditions observations will get a different weight. Not every result will be accepted as "observed phenomenon," but the observer will refuse some results as "modified by secondary phenomena." This distinction is of greatest importance when the clear line of basic research is to be followed, the necessity of which is imperative in physical medicine as in any other science.

1947
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American Congress of Physical Medicine

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Nathan Polmer, M.D.

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ARCHIVES of PHYSICAL MEDICINE

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.·. EDITORIALS .·.

ELECTRICAL STIMULATION OF MUSCLE

Although certain physical properties of electricity were known to the ancients it was William Gilbert, physician to Queen Elizabeth, who is credited with bringing this modality to the attention of the profession and granted him, rightfully or wrongfully, the title of "Father of Modern Electricity." However, Doctor Gilbert was probably too busy attending the "good" Queen to leave any recorded contribution for the use of electricity in medicine. The priority for its medical use is somewhat in doubt. According to Coulter (Coulter, John S., Clio Medica Vol. VII, Physical Therapy, New York, Paul B. Hoeber, 1932), the German Kratzenstein in 1744 "cured a woman of a contracted little finger in a quarter of an hour" and Jallabert "cured the right arm of a blacksmith who had been paralyzed for fifteen years by a blow of a hammer," by producing sparks which when "drawn from the affected arm caused the individual muscles to contract." The writings on electrotherapy during the 18th and 19th century show the development of electricity for the various neurologic problems. Many illustrious names are associated with these early efforts. During the first part of the twentieth century the different electrical currents were employed less frequently owing to the fact that several clinicians and neurologists considered them useless or even harmful. Only during the past few years has interest again been actively aroused in this phase of electrotherapeutics.

The literature during the past twenty years has been confusing to say the least. The reports from excellent investigators contradict the work of other excellent investigators. Part of the difficulty has been the lack of uniformity in experimentation with most of the conclusions derived from studies of animals. Obviously controlled experiments on man have been impossible. Many points of electrotherapy have been discussed with the type of current creating the greatest dispute. In this country interest has been centered chiefly on the action of the direct currents and all their modifications whereas abroad prior to the war considerable investigative endeavor had been done on the so called "progressive currents" in which a series of condensers were arranged and which permitted the stimulation of the muscles most involved. Other phases of the problem were studied with conflicting results.

The cause for the atrophy of denervated muscles has also led to differences of opinion. According to certain physiologists the changes in muscles deprived of their nerve supply are due to fibrillation which give rise to "small irregular action potentials" and persist until the muscular elements have undergone complete atrophy. It has been shown that a denervated muscle is hypersensitive to acetylcholine but whether this is the result of fibrillation is not known. That active muscle contraction leads to changes in the amount of acetylcholine has been proven, however, Dale and his workers

have demonstrated that direct stimulation of denervated muscle does not cause the release of acetylcholine. Such facts and many others of equal or even greater importance which are concerned with normal and denervated muscle activity should be understood when electrical stimulation of muscle is considered. This conception of atrophy due to fatigue and exhaustion is challenged by other physiologists who explain the muscular changes as due to disuse. Their arguments are also convincing.

The papers in this issue of the ARCHIVES by Osborne and his group at Northwestern illustrate the difficulties encountered and the many factors that must be taken into consideration. An electrical current may be the most physiologic but will not be practical or be tolerated by a human patient. There are many problems yet to be solved. However, this work which is here reported plus the contributions of all the other investigators will eventually evaluate this physical measure. With this knowledge this modality will be made more effective and satisfactory and its use placed on a rational rather than on an empirical basis.

MEDICAL NEWS

Physical Medicine at St. Luke's, Chicago

The departments of physical therapy and occupational therapy at St. Luke's Hospital, Chicago, were reorganized and combined to form a department of Physical Medicine. Dr. John S. Coulter is the medical director and Miss Eunice Wallis, B.S., is technical director. This reorganization is in keeping with the change in name of the Council on Physical Medicine of the American Medical Association, which was formerly the Council on Physical Therapy.

New York Society of Physical Medicine

At the regular December meeting of the New York Society of Physical Medicine the following program was presented: "Muscle-spasm, spasticity and rigidity," Dorothy Ludwig, M.D., Assistant Chief, Department of Physical Medicine, Veterans Administration, New York (by invitation); "Environmental control of air-borne contagion; ultraviolet radiation as a means of building up resistance in the individual and in the community." Part I. Theory, William F. Wells, B.S., University of Pennsylvania, Department of Public Health and Preventive Medicine (by invitation); Part II, Clinical practice in Pleasantville, N. Y., Mildred W. Wells, M.D. (by invitation).

The report of the nominating committee naming officers for 1947 was as follows: President, Karl Harpuder, M.D.; Vice-President, Charles G. Buckmaster, M.D.; Treasurer, Richard Kovacs, M.D., and Secretary, Madge C. L. McGuinness, M.D. The members of the Executive Committee named were: Chairman, Harold Neifeld, M.D.; William Bierman, M.D.; Edward F. Hartung, M. D.; Michael J. O'Connor, M.D., and Jerome Weiss, M.D.

Dr. Hibben Talks on Medico-Legal Problems

A symposium was presented to members of the Los Angeles County Medical Association, on the general subject, "The Nurse and Today's Malpractice Suit Hazard."

Dr. Hibben, a member of the medical defense committee of the Los Angeles County Medical Association which sponsored the program, spoke on "The Nurse and Physical Therapy."

General Kirk Awarded Legion of Merit

Major General Norman T. Kirk, the Surgeon General, recently was awarded the Legion of Merit for his service as Commanding Officer of Percy Jones General Hospital during 1942 and 1943.

Presentation was made in the Pentagon by Major General Henry S. Aurand, Comamnding General of the former 6th Service Command during that time and now Director of Research and Development, War Department General Staff.

The citation read, "Major General Norman T. Kirk rendered exceptionally meritorious service as Commanding Officer, Percy Jones General Hospital, from June 15, 1942, to April 13, 1943. His conspicuous performance as an organizer, administrator, and professional surgeon culminated in the establishment of the country's largest Army Hospital Center which has been unexcelled for eminent achievement in military medicine."

Hospitals Approved for Residency Training in Physical Medicine

[1]Los Angeles County Hospital, Los Angeles.
[1]Massachusetts General Hospital, Boston.
Mayo foundation, Rochester, Minnesota.
Michael Reese Hospital, Chicago.
[1]Montefiore Hospital for Chronic Diseases, New York City.
[1]Mount Sinai Hospital, New York City.
Passavant Memorial Hospital, Chicago.
[1]Presbyterian Hospital, New York City.
St. Luke's Hospital, New York City.
Stanford University Hospital, San Francisco.
[1]State of Wisconsin General Hospital, Madison, Wisconsin.
[1]University of California Hospital, San Francisco.
[1]University Hospitals, Minneapolis, Minnesota.
Walter Reed General Hospital, Washington, D. C.
University of Kansas Hospital, Kansas City, Kansas.
[1]Goldwater Memorial Hospital, New York City.
[1]Hospital for Joint Diseases, New York City.
[1]Cleveland Clinic Foundation, Cleveland, Ohio.
[1]Hospital of the University of Pennsylvania, Philadelphia.
[1]Medical College of Virginia, Hosp. Div., Richmond, Va.
[1]Veterans Hospital, The Bronx, New York City.

1. Indicates temporary approval.

Physical Medicine Service Established in Army Hospitals of More Than 750 Beds

Physical medicine has taken its place alongside medicine, surgery, neuropsychiatry and nursing as a professional service in Army general hospitals, and station hospitals of 750-bed capacity or over, Major General Norman T. Kirk, the Surgeon General announced.

By order of the Secretary of War, War Department Circular No. 349, published November 28, 1946, established the Physical Medicine Service in the postwar system of Army hospitals and transferred physical therapy from the Orthopedic Section to the Physical Medicine Service wherever this service was installed. The present standing of physical medicine was achieved because of the beneficial results obtained by its use in definitive medical care and in shortening the period of convalescence.

Early this year, the Reconditioning Consultants Division in the Office of the Surgeon General was abolished as such. This was in name only, as its functions were continued and uninterrupted, with educational reconditioning and other non-professional aspects of the Reconditioning Service being absorbed by the newly-created Convalescent Services Division. The Physical Medicine Consultants Division in the Office of the Surgeon General, established at this time on a purely professional level, assumed the supervision of occupational therapy, physical reconditioning and physical therapy.

As it stands now, the Physical Medicine Service includes the scientifically coordinated and integrated employment of physical therapy, occupational therapy and physical reconditioning in the professional management of the sick and wounded. Its mission is to carry out these therapeutic accessories to medicine and surgery which insures the uninterrupted high type of care accorded soldier patients, and aid, dynamically, in the more rapid convalescence of these patients. Chief of the Physical Medicine Consultants Division is Lieut. Colonel B. A. Strickland, Jr., MC, Office of the Surgeon General. In the field the Physical Medicine Service will be under the direction of a qualified medical officer designated as chief of that service in each Army general hospital. He will have other medical officers as assistants, as well as trained physical therapists, occupational therapists and physical reconditioning experts. In station hospitals of 750 beds and over on Army installations, a Physical Medicine Service may be established by the commanding officer, provided there is a medical officer present who is qualified to manage such a program.

Approval of the Surgeon General is necessary to establish such a service in hospitals of less than 750-bed capacity. In hospitals of this size the physical therapy department will continue as a unit of the Orthopedic Section, and reconditioning activities, including occupational therapy, will be continued as heretofore under the Reconditioning Service.

An enlarged occupational therapy program was set up under Physical Medicine. Activities which are continuing under occupational therapy are woodworking, printing, plastics, photography, weaving, jewelry and metal work, ceramics, typing, radio, fly-tying, leather work, knotting, drawing, sketching and water colors.

It is mandatory that a functional occupational therapy clinic be available at each general hospital, or that a general occupational therapy department be limited to prescription patients, only, for certain periods.

Physical reconditioning has continued uninterrupted for both bed and ambulant patients, and under the Physical Medicine Service this activity supervises closely their physical exercises which is prescribed scientifically by trained medical officers.

The Convalescent Services Division, officially established in larger Army hospitals on December 3, absorbed the non-professional functions formerly carried out by the Reconditioning Service. In the Army's overall postwar convalescent program, this vital activity is charged with presenting a coordinated, planned program of recreation, orientation, education and amusement for the high morale of both patient and duty personnel in Army hospitals.

Principal branches of this division are Special Services, Information and Education, Educational Reconditioning, Personal Affairs, Classification and Counseling, and liaison with other departments engaged in patient care.

Veterans Administration

Dr. Walter S. McClellan has been appointed Chief of Physical Medicine and Rehabilitation, Veterans Administration Hospital, Saratoga Springs, N. Y.

Branch Office No. 7, Veterans Administration, Chicago, sponsored a medical rehabilitation conference in Chicago, Dec. 16, 17 and 18. An extensive program with many prominent speakers was given during the three day session. Dr. George B. Benson, Assistant Chief, Medical Rehabilitation Section, presided over the conference. "Rehabilitation in Civilian Hospitals" was presented by Dr. John S. Coulter, Consultant Chief, Medical Rehabilitation Section. Other speakers and their topics were: "Rehabilitation Present and Future," Donald A. Covalt, M.D.; "The Scope of the Shop Retraining Program in Rehabilitation," Robert Ingalls; "Rehabilitation and Tuberculosis," Andrew Goesl; "Programs for Educational Retraining," E. R. Belknap; "Values of Psychotherapy in Medical Rehabilitation," J. P. Roberts, M.D.; "Rehabilitation Board," Louis B. Newman, M.D., and "New Horizon for Occupational Therapy," Mary F. McDonough, O.T.R.

The authorized hospital capacity of Veterans Administration has passed the 100,000-bed mark for the first time in history.

The new record was set with the recent acquisition of six more Army and Navy hospitals in the program to provide beds for the increasing number of veterans who need hospitalization while VA's big hospital construction project is in progress.

The six recently acquired service hospitals are Cushing General, Framingham, Mass.; Fort Logan, Colo.; Billings General, Fort Harrison, Ind.; Newton D. Baker, Martinsburg, W. Va.; Moore General, Swannanoa, N. C. and the Naval hospital at San Juan, Puerto Rico.

This makes 28 former Army and Navy hospitals now being operated by VA, either as permanent or temporary installations pending the completion of the hospital construction program.

VA is providing reader service for blinded veterans who must have their study material read to them in order to go to school.

Readers are picked not only for their ability to read intelligently but for their understanding of the problems of newly blinded persons and their ability to test the veteran's understanding of what he is hearing.

Appointments of 19 nationally recognized doctors, nurses, social service workers and dieticians as a special advisory group on the over-all medical care for veterans, was recently announced.

The group was appointed in compliance with Public Law 293, 79th Congress, and Dr. Charles W. Mayo, of the Mayo Clinic at Rochester, Minn., is its chairman.

Music lovers in VA hospitals and homes will find a number of records to suit their tastes among the 7,014 albums and single disc records that VA will purchase.

Selections will range from classics such as Bach's Toccata and Fugue in D Minor and Prokofieff's Classical Symphony to the latest swing music played by Duke Ellington, Xavier Cugat, and the Chamber Music Society of Lower Basin Street.

VA estimated the veteran population at nearly 17,900,000 on Oct. 31, an increase of more than 150,000 over Sept. 30.

VA is operating 29 mental hygiene clinics and has contracts with 39 private clinics for the treatment of veterans in its preventive medicine program.

Over 63,000 World War II veterans are studying farming right on the farm under two Federal laws administered by VA.

More than 40,000 veterans are operating their own businesses with G. I. loans guaranteed by VA.

Around 65,000 veterans are applying monthly for admission to VA hospitals or homes.

Odd - Shoe Exchange in St. Louis for Amputees Who Do Not Use Artificial Limbs Is Proving Its Worth All Over the U. S.*

Among the letters received during the past few weeks by this department was one which read: "I am a disabled veteran who lost my left leg in combat in Italy. As I do not wear an artificial leg and therefore wear a shoe on my right foot only, I have an extra shoe each time I buy a pair. I now have four new left shoes, size 10½E, which, although new, are useless to me. It seems to me that these shoes could be worn by a veteran who had lost his right leg if I just knew how to get in touch with such a man. What is the answer?"

Although this request is unusual, its most interesting aspect is that there is an answer, for this letter was sent immediately to the National Odd Shoe Exchange in St. Louis, Mo. A unique service organization, the exchange was started in 1943 by Ruth C. Rubin an occupational therapist. As a result of infantile paralysis, Miss Rubin, like many other persons wears shoes of different sizes. As it is possible to purchase shoes only by pairs in matched sizes, it was necessary for her to always purchase two pairs of identical shoes and then discard the nonwearable shoe for each pair. The result was that her shoes cost her double the usual price. Added to the irritation of the double cost was the problem of what to do with the odd shoes. One day while she was preparing to dispose of a number of unused shoes the idea of an exchange occurred to her.

She wrote a number of medical societies, hospitals, the National Foundation for Infantile Paralysis and other organizations interested in the handicapped, explaining the service she planned to provide. Almost immediately she began to receive letters from amputees and those with mismated feet. Miss Rubin made no attempt to store accumulated shoes, but started and now maintains an extensive filing system in which is

* Rusk, N. Y. *Times.*

recorded the name, age, sex, shoe size and the type of shoes available and desired. When she finds two persons wearing opposites she puts them in touch with each other. From this point they are on their own to make mutual arrangements for trading and exchanging accumulated shoes.

International Society of Medical Hydrology

The first post-war annual meeting of the society was held at Buxton from Oct. 4 to 6.

Dr. Abraham Cohen, of the Philadelphia General hospital, gave an account of the use made in his hospital of physostigmine in the relaxation of muscle spasm. He referred to the experience of other workers with "Prostigmin" but maintained that physostigmine salicylate was equally efficacious, less expensive, and less toxic. The method adopted in the arthritis (inpatient) ward was to give all patients injections of isotonic saline daily for a week.

Dr. Loring Swaim discussed American concepts of the treatment of chronic rheumatic diseases, stressing the importance of individual reactions to personal and social environment, and the responsibility of the physician to reorientate the patient.

Fellowships Available

Dr. Thomas Parran, Surgeon General of the United States Public Health Service Federal Security Agency, announces that approximately 120 one-year fellowships in medical research are open to men and women who are graduate science students.

The National Institute of Health offers research fellowships to graduates of accredited colleges who have majored in such subjects as biology, chemistry, dentistry, entomology, medicine, physics and other scientific fields.

Paying a yearly stipend of $3,000, Senior Research Fellowships are awarded to men and women who hold Ph.D. degrees in one of the specified scientific subjects. Junior Fellows, who receive $2,400 annually, must hold a master's degree in science, or must have completed the equivalent of a master's degree in postgraduate study. Fellowships are for one year from the date of award, and may be renewed for a second year.

Applications for fellowships and traineeships should be sent to the Director, National Institute of Health, Bethesda, Maryland.

Mississippi Valley Medical Society 1947 Essay Contest

The Seventh Annual Essay Contest of the Mississippi Valley Medical Society will be held in 1947. The Society will offer a cash prize of $100.00, a gold medal, and a certificate of award for the best unpublished essay on any subject of general medical interest (including medical economics and education) and practical value to the general practitioner of medicine. Certificates of merit may also be granted to the physicians whose essays are rated second and third best. Contestants must be members of the American Medical Association who are residents of the United States. All contributions shall be typewritten in English in manuscript form, submitted in five copies, not to exceed 5000 words, and must be received not later than May 1, 1947.

Further details may be secured from Harold Swanberg, M.D., Secretary, Mississippi Valley Medical Society, 209 - 224 W. C. U. Building, Quincy, Illinois.

Institute of Occupational Medicine

Announcement is made of the establishment of an Institute of Occupational Medicine and Hygiene at Yale University. Dr. Ronald F. Buchan, newly appointed assistant professor of industrial medicine, has been named head of the institute with the title of clinical director.

Malpractice: Liability of Physician for Departing from Approved Methods

The plaintiff sued for damages for injuries resulting from the alleged negligence of the defendant in the treatment of a fracture. From a judgment for the plaintiff, the defendant appealed to the Supreme Court of North Carolina.

The plaintiff fractured one of the bones in her right forearm and engaged the defendant physician to treat her. He set the bone and put the arm and wrist on a board splint. Later he removed the board splint and substituted a metal cast, at the same time massaging the plaintiff's arm and hand. The defendant subsequently visited the plaintiff once or twice a week, the plaintiff testifying:

> Each time he came he brought a tube or something and massaged my arm. He would take my arm out of the cast and massage it. He would not support the broken part of my arm while he was massaging it. . . . He held it with the fingers in one hand and rubbed my arm and hand with his other hand.

After about three months the plaintiff's hand was so drawn and bent that she could not use it, and the defendant took her to another physician who examined her arm and took an x-ray. He found the bone out of position and testified that the displacement could have occurred when the physician removed the arm from the splint. The plaintiff introduced expert evidence to the effect that the manner in which the defendant massaged the plaintiff's arm "was unusual" and not according to the general practice, and that "too frequent removal of a broken bone from the cast is bad practice . . ."

The Supreme Court said that a departure from approved methods in general use, if injurious to the patient, suffices to carry the case to the jury on the issue of negligence. On the basis of all the evidence the court was of the opinion that the removal of the cast once or twice a week and the massaging of the plaintiff's arm and hand without any support under the broken part was unusual and a departure from approved methods in general use. The jury was warranted, concluded the court, in finding that such conduct was injurious, so the judgment for the plaintiff was accordingly affirmed. — *Davis v. Wilmerding*, 24 S. E. (2d) 337 (N. C., 1943). J. A. M. A. **132**:736 (Nov. 23) 1946.

American Occupational Therapy Association

The American Occupational Therapy Association announces plans for the publication of its official journal under a new name, *The American Journal of Occupational Therapy* which is scheduled to make its first appearance in February, 1947. Editor of the Journal will be Miss Charlotte D. Bone, and assistant editor will be Miss Katharine Rand. Publishing duties of advertising and production have been assigned to Mr. Shepley Cleaves of Boston. Dr. Dunton who was editor of *Occupational Therapy and Rehabilitation* has retired. It is understood that *Occupational Therapy and Rehabilitation* will continue to be published but it will no longer be the official organ of the American Occupational Therapy Association.

The Improved Vocational Rehabilitation Program

The director of the office of Vocational Rehabilitation, Michael J. Shortley, Washington, D. C., has announced that the states and the federal governemnt have set a goal of 150,000 for civilians to be rehabilitated into employment each year, almost four times the number prepared and placed in suitable occupations in any one year to date. Budgetary estimates of the states indicate that there is a minimum of 1,168,000 physically or mentally handicapped persons of working age—not including veterans with service connected disabilities—in need of vocational rehabilitation services. Every state in the Union operates a civilian vocational rehabilitation program with the assistance of the federal government, Shortley said.

New Journals

Announcement is made of the publication of a new scientific review, *"Atomes and Radiations—Physique, Biologie—Medicine."* The editorial offices are located at 43, Boulevard Malesherbes, Paris, 8.

Postgraduate Medicine, a new monthly journal appearing in January, 1947, is the official publication of the Interstate Postgraduate Medical Association of North America. The business office is located at 515 Essex Building, Minneapolis, Minn.

Medical Care Institute

A Medical Care Institute was the subject of a three day session at Western Reserve University, January 16, 17 and 18, 1947. The general title was ,Whither Medical Care and Human Values? A Challengo to Social Workrs."

Mayo Clinic Resumes Training of Physical Therapists

The Mayo Clinic has reopened courses for the training of physical therapists. The course which was discontinued in February, 1946, has been reapproved by the Council on Medical Education and Hospitals of the American Medical Association.

Mississippi Valley Medical Society Meets at Burlington, Iowa, Next October 1-2-3

The 12th Annual Meeting of the Mississippi Valley Medical Society will be held in the half million dollar Municipal Auditorium at Burlington, Iowa, October 1, 2, 3, 1947, under the Presidency of W. A. Sternberg, M.D., F.A.C.S., of Mt. Pleasant, Iowa, a Trustee of the Iowa State Medical Society.

Physical Medicine at Percy Jones

Professional staff programs are scheduled weekly at the Percy Jones General Hospital, Battle Creek, Mich. On January 9, Lt. James B. Hurd presented the subject, "Electronic Emissions," as part of the Seminar on Physical Medicine. Capt. F. W. Clark took part in the Physical Medicine Seminar of January 16 and gave as his subject, "Explanation of the Electrical Phenomenon Manifested in the Various Stages in the Reaction of Degeneration."

80th Annual Meeting West Virginia State Medical Association

The Kanawha Medical Society has invited the West Virginia State Medical Association to hold the 80th Annual Meeting in Charleston, Monday, Tuesday and Wednesday, May 12, 13 and 14, 1947. Information concerning room reservations will be carried in the February issue of the West Virginia Medical Journal.

Physical Therapists, U. S. Public Health Service

Authority has been granted for placing physical therapist positions in the U. S. Public Health Service in the professional service. All physical therapists, professionally qualified, entering the Public Health Service hereafter, will be appointed in the professional grades. As a result of this action, professionally qualified physical therapists now in the subprofessional grades will be reallocated to appropriate professional grades, consistent with authorized staffing and after consideration of individual qualifications.

BOOK REVIEWS

ASCLEPIUS: A COLLECTION AND INTERPRETATION OF THE TESTIMONIES. By *Emma J. Edelstein* and *Ludwig Edelstein.* Volume I. Cloth. Pp. 470. Volume II. Cloth. Pp. 277. Price, $7.50. Baltimore: The Johns Hopkins Press, 1945.

These two volumes are publications of the Institute of the History of Medicine, The Johns Hopkins University. The interest in Asclepius and his cult centers in two considerations. Asclepius, almost throughout antiquity, was the main representative of divine healing, a highly important form of ancient medical treatment, and as such never opposed by ancient physicians. Moreover, the worship of Asclepius, beyond its medical significance, came to play such a role in the religious life of later centuries that in final stage of paganism, of all the genuinely Greek gods, Asclepius was judged the foremost antagonist of Christ. Aiming thus at an understanding of the problem of Asclepius in its widest sense, the first volume contains a collection of the ancient references to the life and deeds of Asclepius, his cult, his temples and his images. The second volume is concerned with an analysis of the material assembled. The quotations are put down verbatim.

The authors say several things that are illustrated by the following quoted paragraphs. There is no generally accepted pattern that one is able to follow in studying any of the ancient deities. Besides, the material available in every instance, by its quality and its peculiarity, enforces ever varying rules of analysis.

Southernwood is destructive to harmful organisms and removes the tapeworm. . . . A woman had a tapeworm and the cleverest physicians failed to cure her. Then she came to Epidaurus and begged the god that she might become free of the ailment that lived within her. The god was not present. The attendants at the temple, however, made the woman lie down where the god was accustomed to heal the suppliants. . . . They removed her head from her neck. One stretched down his hand and pulled forth the worm, an animal of great size. But fit together and attach her head to its original joint, they could not do. The god then approached and was provoked at them because they set themselves to a task beyond their wisdom. But with a certain effortless divine power he himself attached her head to her body and raised up the stranger-woman.

Ca: Bringing the man, most miserable then
But who so happy, who so prosperous now?
Without delay we took him to the sea
And bathed him there.

O what a happy man,
The poor old fellow bathed in the cold sea.

. . . Then the old lady when my steps she heard
Reached out a stealthy hand; I gave a hiss,
And mouthed it gently like a sacred snake.
Back flies her hand; she draws her coverlets
More tightly round her, and, beneath them, lies
In deadly terror like a frightened cat.
Then of the broth I gobbled down a lot
Till I could eat no more, and then I stopped.

Wife: Did not God approach you:
Ca: Not till later.
And then I did a thing will make you laugh.
For as he neared me, by some dire mishap,
My wind exploded like a thunder-clap.

Wife: I guess the God was awfully disgusted.
Ca: No but I also blushed a rosy red
And Panacea turned away her head
Holding her nose: my wind's not frankincense.

These books give an insight into the essence of the figure of Asclepius and of the cult attached to him. It also provides a commentary on the whole ancient testimony on Asclepius preserved in books and on stone.

ENVIRONMENT WARMTH AND ITS MEASUREMENT (a Book of Reference Prepared for the Royal Naval Personnel Research Committee of the Medical Research Council). By *T. Bedford,* D.Sc., Ph.D., M.I. Min. E. Price, 25c, from B.I.S., New York. Pp. 40. Published by H.M.S.O., London, 1946.

This reference is another one in the series of authoritative and technically excellent research reports by the Medical Research Council of Great Britain. This research was brought on by the realization that in the British Navy the efforts to increase to the maximum the mechanical fighting strength and fire power of the ship by extra machinery has lead to a deterioration of the living conditions of men; with the subsequent loss in morale and physical condition of the men. Hence it became imperative to determine by research and experiment: What is the ratio of the space allotted to the human element, to the space allotted to the fighting machine (ship plus ship's company) which will make it the most efficient engine of war. To answer this question numerous observations are required on the temperature, humidity movement and bacterial count of the ship's atmosphere, and it was also essential to institute standard methods of measuring the environmental warmth in ships under all conditions of service.

This volume contains the full description of the basic considerations and procedure employed in the solution of this problem. Its main sections are: Body production and heat loss; instrumental measurements; effective temperature and corrected effective temperature; procedure in making tests; ventilation reports; working at extreme temperatures; references, tables and formulae. In the appraisal of results it has been recommended that, wherever practicable, the corrected effective temperature in spaces where men live or work should be kept below 80 degrees F. It is especially desirable that this should not exceed 86 degrees F. even in tropical waters, unless the temperature of the external air exceeds 100 degrees F. Furthermore, if excessive corrected effective temperatures are found, all possible steps should be taken to reduce them; and the detailed information concerning the individual thermal factors, which is yielded by the instrumental method prescribed, will indicate in what direction the rem-

edy should be sought. Thus, if it is found that the mean temperature of the solid surroundings is appreciably higher than the air temperature, surface thermometers should be used to trace the source of radiant heat, and the question whether further lagging or screening of hot surfaces is practical should be considered. Such additional insulation would be of twofold advantage; it would reduce the mean temperature of the surroundings, and would also lower the air temperature. In another situation, a low air velocity may suggest the desirability of increased air movement, contrived by improved ventilation, or by the use of a table fan, or often by the proper use of "punkah louvres"; again, a dew point temperature substantially above that of the external air will indicate the need for better ventilation. If the air supplied by the punkah louvres is appreciably hotter than the external air, and especially if its dew point is high, check the condition of the fans and of the supply ducts.

These results, and the technic of investigation so comprehensively reported, should be of great interest to physicians, physiologists and public health engineers, as well as physicists in the armed forces and civilian life.

THE PECKHAM EXPERIMENT—A STUDY IN THE LIVING STRUCTURE OF SOCIETY. By *Innes H. Pearse,* M.D., and *Lucy H. Crocker,* B.Sc. Cloth. Price, $3.50. Pp. 324 with 46 illustrations. New Haven, Conn.: Yale University Press, 1946.

Here is a book that is different. It is a study of people in a district in London called Peckham. It was originally started as an experiment to learn about human beings in anything but the traditional health center set up. As a matter of fact the investigators rather disliked the idea of being considered a medical center and spoke of their place as the "Centre" and their check up of families or individuals as a periodic health overhaul and not the usual medical overhaul. The practice of health was accentuated which to the investigators is not the same as the practice of medicine. This new approach is significant and at first somewhat difficult for the average medical man to comprehend whose training and thinking and directed and conditioned for the detection of diseases and disorders. To be sure they found 91 per cent of the individuals had some "physiological deficiency, defect or aberration." However this is not a book which goes into detail with charts, tables, etc., as to types of diseases. This is merely mentioned as one of the justifications for the project. The purpose of the health overhaul was not only to check the individual's physical efficiency but also his capabilities as related to the family and its social life. They observed 1206 families comprising 4002 individuals over a period of four and a half years.

The first chapters set forth the principles and background of the experiment. These ideas may be new to much of the present day thinking. For example they believe that man has a free will and that he has a certain control of his environment which to them is a "progressive mutual synthesis participated in by both organism and environment, the wholeness of which is Health." Following these thought provoking chapters are those that deal with the workings of the "Centre" and its influence on the natural development of this theme of health.

Throughout the book the emphasis is on the family which to them is a "functional unity." In the prenatal consultation not only the wife takes part but the husband as well. The pregnancy is to be understood by both partners and watched carefully as something to be cherished and guarded. These quotations will partially illustrate this conception: "we begin to see that the child is not just a delightful and special sort of luxury which a young couple may or may not be able to afford it. It is Nature's means by which both man and woman *reach their own maturity* (authors' italics). In healthy parents each successive pregnancy will hold some possibility for changing and maturing both of them." "Man devoid of virility and ignorant of the implications of his devitalization is reducing this family environment to poverty and monotony by stocking it with one or at the most two children." Many of the ideas expressed will anger and annoy the "modern" mother or modern family or even set up howls from the so-called modern physician who has tried so hard to subordinate the responsibilities of parenthood. Neither will the "technologist" with their "scientific" control of parenthood be happy with the remarks about courtship and mating. To the authors the family is the nucleus of society just as the atom is the starting point for the physicist or the cell for the physiologist. To them pregnancy is a natural state which applies to the delivery and puerperium as well. They arrange for delivery at a hospital in the neighborhood where the mother remains only 48 hours not so much to shorten hospital stay but so that the mother and the new baby may be together with the family, fulfilling the desire to maintain the family function. This viewpoint is not new but has been forgotten too often in this modern era.

The discussion of puberty and adolescence is instructive in bringing to light certain "action patterns" of the boys and girls which were observed as they conducted themselves at the "Centre." Statements such as the following are challenging especially to us in America: "boys who go to work at 14 show an all-around functional development while those who continue at school seem overgrown as though their development were distorted"; "in girls who enter industry early it is marked in many ways by a persistent general immaturity accompanied by a precocious development of femininity." A chapter on "Social Poverty" is most interesting in which social pathology is considered from a different aspect than that of sociologist or social reformer. They summarize the difficulty in a lacking of "personal, family and social opportunities for knowledge and for action that should be the birthright of all."

The ideas demonstrate a profound and intelligent understanding of human relationship, a fundamental knowledge of biology, psychology and physiology all combined together with sound philosophy. The realist will read the book and say it just cannot work; for him it all sounds too idealistic, too much out of this world. Objections and doubts continually project themselves in the mind of the reader but

they are overcome in most instances by the reasonableness of the logic of the authors. No doubt there are faults and misgivings in such a project which are probably more obvious to the authors than to the reader.

Numerous phrases and sentences are found throughout the book which are not only poetical in themselves but which have a force. The following are examples: "many straws blowing in the winnowing of pathology," "prepared to sail upon the open sea of humanity where the manifold winds of the environment play in ceaseless change, he may set out on a further search into the science of living," "tilling the familial and social soil becoming a science and art to be acquired whether it is sought in virgin ground or in the weeded fallow from which disorder has been cleared, Health is a cultivator's problem," "nature like a knitter weaves her living fabric on two needles—the sexes," "though the shoots and branches will burst through the bark and clinging corky layers of the old trunks, such sporadic outburst, proof enough of what the development might have been, cannot now contribute to the tree-like contour of the family." The temptation is to quote many more.

This book is as fascinating as a novel and much more stimulating. It is beautifully written and in the style characteristic of British prose which is commendable for its charm and leisureliness. Anyone reading this book cannot help but be captivated by the intense interest, sincerity and courage of the authors and be infected with their unbounded hope and enthusiasm. This work is not for the dour, pessimistic individual nor for the cynic who has lost hope in humanity. It will be profitable reading not only for all professional men but for educators, sociologists, social workers and any intelligent human being as well.

A HISTORY OF THE AMERICAN PHYSIOTHERAPY ASSOCIATION. By *Ida May Hazenhyer,* M.A. Paper. Pp. 39, with 6 illustrations. Price, $0.50. New York: American Physiotherapy Association, 1946.

This is a history of the physical therapists' association, divided into four parts: Part I, Pioneering Days, 1921-1925; Part II, Formative Years, 1926-1930; Part III, Coming of Age, 1931-1938; and Part IV, Maturity, 1939-1946. In March, 1921, there appeared on the publication horizon a new journal, a sixteen page magazine. At the top of the cover stood the name in black letters, "P. T. Review." At the bottom of the cover: Published by the American Women's Physical Therapeutic Association.

It directs attention to the fact that owing to the activities in three different places in the East, the actual birthplace of the association is a somewhat controversial question. However, the most convincing records point to Keen's Chop House in New York City, where a meeting was held on Jan. 15, 1921. According to the records, about thirty aides were present, and at the meeting with them were Lieut. Col. Frank B. Granger, Major McFee, of Boston, Lieut. Col. Corbusier, of Plainfield, N. J., Major Ney, of New York, Major Samson, of Fox Hills, and Commander Bainbridge, from the Navy Hospital. This is an interesting history, especially to all who are in the field of physical therapy.

ESSENTIALS OF PHARMOCOLOGY AND MATERIA MEDICA FOR NURSES. By *Albert J. Gilbert,* M.D., Instructor of Pharmacology, Aultman School of Nursing, Canton, Ohio, and *Selma Moody,* R.N., Instructor in Nursing Arts, the Presbyterian Hospital of the City of Chicago. Second edition. Cloth. Price, $2.50. Pp. 290, with 20 graphs and photographs and five colored plates. St. Louis: C. V. Mosby Company, 1944.

This volume is a concise text in pharmacology and materia medica intended for use in nursing schools. It is arranged to conform to the outline contained in the "Curriculum Guide for Nursing Schools." This edition has been brought up to date by the addition of material on new drugs such as penicillin, the sulfonamides, diethylstilbestrol, evipal, adrenal cortex extract, aluminum hydroxide gel and crystalline zinc insulin.

After an introduction containing general information on drug sources, active principles, drug laws, etc., there are chapters on drugs and solutions and on posology. The discussions of the various drug preparations are presented for the most part by systems. The final six chapters, however, are on specifics, hormones, vitamins, serums and vaccines, toxicology and prescription reading. Discussions of the major drugs are taken up under the headings of preparations, dosage and administration, action and uses and untoward effects. Considering the brevity of the text, the discussions are well done and easily understood. Some teachers, however, might consider them too brief. The sulphonamides and penicillin, for example, are presented in a little less than ten pages. Those who might not consider the volume adequate as the main teaching text, would, as the author suggests, find it excellent for review purposes. It is a worthwhile achievement to condense and present so much material in such small space.

INSIGHT AND PERSONALITY ADJUSTMENT: A Study of the Psychological Effects of War. By *Therese Benedek,* M.D., Institute for Psychonanalyis, Chicago. Price, $4.00. Pp. 307. New York: The Ronald Press Company.

This volume depicts the apprehensions, expectations and discouragements of the changing fortunes of war as they are conveyed in psychiatric consultations, in the patients' reactions to and reflections on war. It is written with full understanding of the emotional dynamism of the interrelationship and the conflicts which arise during and after the war in the individual and his family. Part I, The individual, contains chapters on the "Development to Love," "Marriage" and "Psychodynamics of Separation." Part II analyzes the soldier, the influences of army life, the emotional situation and the failures of adaptation after returning. Part III deals with the family in war and Part IV with

men, women and the changing sexual morals. This is a well written and well balanced volume, not a "war-book," but a reflection on its effects on the emotions and destinies of individuals and their families. It should be of considerable help to those whose professional task during the years to come will be to assist individuals in all walks of life, social workers, physicians, psychologists, teachers and counselors.

ANOXIA: ITS EFFECT ON THE BODY. By *Edward J. Van Liere,* Ph.D., M.D., Dean of the School of Medicine, Professor of Physiology, West Virginia University. Second printing. Fabrikoid. Pp. 269 with illustrations. Price, $3.00. Chicago. University of Chicago Press, 1942.

This book, which first appeared in 1942, has become a standard textbook for physiologists and others working with the problems of anoxia. It contains in clear form most of our present knowledge of this subject with the exception of the restricted work done under conditions of war secrecy The book has excellent charts and an extremelv useful bibliography.

WHAT YOU DON'T KNOW MAY HURT YOU! By *J. A. Rudolph,* M.D., and *Howard N. Rose,* B.A. Cloth. Price, $1.50. Pp. 138. Philadelphia: Dorrance & Co., 1946.

Just another book written for the layman to help him think he can make his own diagnosis. According to this one practically all the complaints the human body endures can be traced to allergy. Only here the suffering individual must see THE Specialist, the allergist. According to the authors this super intelligence snoops around at the patient's work or at his home, he finds the causes for all the unhappiness in marital relationship, he even fights the case before the Industrial Commission for his boy Fred so that his 'living expenses as well as his medical bills" are cared for, but not only for Fred "but also of the millions of other individuals employed in industry." Perhaps some day the poor layman will become sensitive or allergic to this type of writing.

STUDIES IN SCIENCE. Edited with a Foreword by *W. C. Coker,* Kenan Professor of Botany. Cloth. Pp. 375, with illustrations. Price, $3.00. Chapel Hill: The University of North Carolina Press, 1946.

This book represents Volume LXI of the "Journal of the Elisha Mitchell Scientific Society," and also forms a part of the Sesquicentennial Publications of the University of North Carolina. The contributions describe research done in the many departments of the University such as Chemistry, Mathematics, Physiology, Public Health, Pharmacology, Psychology and Zoology. These are true scientific papers written for the scientists to build up a spirit of research and an increased interest in this type of work. Many topics of special interest to physicians are included on such divergent topics as the production of penicillin, metabolism of quinine, parathyroid cysts, blood volume after hemorrhage and environmental factors in sexual inversion. An interesting book for the trained scientist.

DR. MORTON: PIONEER IN THE USE OF ETHER. By *Rachel Baker.* Illustrated by *Lawrence Dresser.* Cloth. Pp. 224. Price, $2.50. New York: Julian Messner, Inc., 1946.

This is an entertaining account of the trials and tribulations encountered by Dr. Morton in relation to his important discovery of the value of ether anesthesia. It is appropriate that this book appears 100 years after the first public demonstration of ether. The reader gets such an intimate knowledge of Dr. Morton as a man that he wishes he might know of the recognition accorded him at this time. Layman and doctor alike should find this interesting reading.

PSYCHOLOGY IN GENERAL PRACTICE. Edited by *Alan Moncrieff,* M.D., F.R.C.P. Cloth. Price, 12s. 6d. Pp. 188. London: Eyre and Spottiswoode, Ltd., 1946.

This is a collection of 16 articles which originally appeared in the *Practitioner.* In America the title of the book would probably be Psychoneurosis or Psychogenic Problems in General Practice for in this country a distinction is made between psychology and pathologic psychology. The chapters were all written by British physicians and include such subjects as Hysteria, Delinquency, Problems of Childhood, Minor Degrees of Mental Defect, Psychosomatic Medicine and the Rheumatism Problem, etc. The chapter on rheumatism is by James Halliday who had an article in the ARCHIVES OF PHYSICAL THERAPY in 1941 on this subject which at that time caused discussion. It is interesting to find this sentence in the article "these patients (that is those with psychogenic rheumatism) love and enjoy all kinds of physical therapy and, although they usually say that it does them good, many obstinately refuse to admit recovery." The chapters are short and the material is presented in a manner which would appeal to a busy practitioner.

PERSONAL HYGIENE APPLIED. By *Jesse Feiring Williams,* M.D., Sc.D., Emeritus Professor of Physical Education, Columbia University. Eighth edition. Cloth. Pp. 564, with 156 illustrations. Price, $2.50. Philadelphia, London: W. B. Saunders Company, 1946.

In addition to presenting clearly a body of facts on the subject of hygiene, the author in this book teaches a philosophy of living so that its quality may be improved. The book is planned for college students, but should be useful also when physicians, teachers, nurses or social workers wish to recommend a book to patients or parents. This new edition contains up to date information on recent advances in physiology, endocrinology and psychiatry which have a bearing on the subject. It is well illustrated, and contains questions and selected readings.

PHYSICAL MEDICINE ABSTRACTS

Rehabilitation of the Injured Hand. Sidney Baron Hardy.

Am. J. Surg. **72**:352 (Sept.) 1946.

Bunnell makes the statement that "Next to the brain the hand is the greatest asset to man, and to it is due the development of man's handiwork."

Certainly, during this last war man has perfected much varied and mechanized equipment all demanding some degree of manipulation by hand and this has increased the incidence of hand injuries. The instinct to protect one's face and to use the hands to help one to safety in the face of danger also subject them to a greater probability of injury. It is hard to conceive that a person could be injured in combat who would not receive, also, some injury to his hands because of this instinct to protect himself. Injuries from these causes augment the large number of hand injuries sustained in combat as the result of direct enemy fire.

Rehabilitaion of the injured hand is probably one of the most difficult tasks which the surgeon is called on to perform. By careful examination and planning, together with meticulous surgery, this work can be accomplished with satisfactory results in many cases. Good cooperation on the part of the patient in taking active hand exercises and receiving good physical therapy are most essential for good results.

Electrical Skin Resistance Test in Evaluation of Peripheral Nerve Injuries. Ernest Herz; Gilbert H. Glasser; Joseph Moldover, and Thomas I. Hoen.

Arch. Neurol. & Psychiat. **56**:365 (Oct.) 1946.

The measurement of electrical skin resistance has been recommended by Richter and Katz and Jasper and Robb as a practical test in the evaluation of injuries of peripheral nerves. This method, in contrast to the sensory examination, does not depend on the cooperation of the patient. It can therefore be used with uncooperative, or even unconscious, patients and may give objective results in cases of hysteria or suspected malingering.

The electrical skin resistance test was evaluated in 87 cases of injuries of the median, ulnar, radial, sciatic, peroneal and tibial nerves. An additional 15 cases of injuries of the brachial plexus were studied. The results of the skin resistance test were correlated with the degree and area of sensory impairment and the degree of motor dysfunction.

In cases of complete nerve injury the area of increased electrical skin resistance coincided well with the area of sensory loss and the degree of motor paralysis. The skin resistance test is therefore valuable in mapping anesthetic areas.

In cases of partial nerve lesions, due either to incomplete injury or to some degree of recovery, there was no regular correlation of the electrical skin resistance, the hypesthetic or hyperesthetic areas and the motor status. Fundamental physiologic and anatomic mechanisms responsible for this irregularity are discussed.

The appearance of decreased electrical skin resistance in the area of distribution of the injured nerve and the whole affected hand is discussed. Certain principles in the evaluation of the course of regeneration with the skin resistance method are considered.

The electrical skin resistance test does not give definite information for the diagnosis and evaluation of partial dysfunction of peripheral nerves.

Penicillin by Iontophoresis. Roy J. Popkin.

J. A. M. A. 132:238 (Sept. 28) 1946.

Recently a report the "Ionization" of Penicillin, appeared in the British literature in which it was stated that penicillin could not be ionized.

This work confirmed the observations of the author in attempting to force pencillin across the normal skin by ion transfer. One hundred thousand units of sodium penicillin was dissolved in 30 cc. of distilled water and applied in asbestos paper through the negative pole. The site chosen was the forearm. The subject was a normal young man. The current was gradually increased to a maximum of 20 milliamperes. The total time was fifteen minutes. Samples of venous blood draining the area were taken immediately after the fifteen minutes of application and fifteen minutes later. Only a trace of penicillin was found in the first sample and none in the second. This experiment was repeated at a later date except that this time the penicillin was applied through the positive pole. In the two samples of venous blood no trace of penicillin was found. Controls receiving penicillin by intramuscular injection showed appreciable activity each time. The broth dilution method with use of a sensitive hemolytic streptococcus was used in these assays.

As many men, especially oculists, are using penicillin by ion transfer, it is felt that this additional information should be brought to their attention.

Treatment of Fracture-Dislocations of the Proximal Interphalangeal Joints of the Fingers. Hartwin A. Schulze.

Mil. Surgeon **99**:190 (Sept.) 1946.

Although not mentioned in the textbooks and apparently not commonly known there is a simple manipulative treatment which is usually successful. This procedure consists in placing the joint into extreme flexion while making traction on the

finger. This reduces both the fracture and the subluxation. In this position the joint is snugly bound by the tensed dorsal aponeurosis including the tendons of the extensor digitorum, the interosesei and the lumbricales. The tonal tension of the flexor tendons also tends to prevent dorsal displacement. Reduction is accomplished with little pain of but brief duration. At the end of a week or ten days the finger is gradually extended while continuing immobilization of the joint and protective splinting. At the end of three weeks splints or dressings are no longer required and active and passive exercises can be instituted.

On the Financial Side of Physical Therapy. Harold P. Dean.

Modern Hosp. **67**:65 (Oct.) 1946.

The Children's Hospital of Los Angeles organized its physical therapy department in March, 1920. It was a small beginning with one physical therapist in attendance and was open two afternoons each week.

A great deal of thought should be given to the space to be occupied. It should be ample enough for probable expansion even though the per capita cost may thereby be slightly increased at the beginning of the program. It will be less expensive and more satisfactory than having to provide entirely new quarters later.

The nature and amount of equipment will depend largely on the type of hospital and the kind of patients served. No standard list of equipment can be given as the requirements vary greatly in different hospitals. It might be wise, at least in a small or medium sized institution, to obtain a few basic pieces at first and make additions according to demand and establishment of definite needs.

Hydrotherapy and massage are perhaps the oldest services of the field and have been introduced successfully with but little equipment. Such services, along with a limited amount of electrotherapy, may be instituted at a small capital outlay. Most directors consider a few electrical machines essential in the usual minimum requirements.

While some small hospitals have made an initial capital outlay of from $3,000 to $10,000 or even more (based on costs in normal times), a satisfactory beginning may be made by purchasing a limited amount of equipment at a savings. At one time, most or all of this could be constructed by the hospital's mechanics at a cost of less than $1,000. Costs have increased today so as to double or possibly triple the expense.

It is considered that a physical therapist can give from seven to fifteen treatments a day. The amount of time required will vary considerably according to the kinds of treatment given. A porter, clerk, Kenny packers and other employes may be needed according to individual cases.

The following should be considered in arriving at a rate schedule: (1) type of hospital; (2) actual cost to hospital; (3) rates set by other hospitals; (4) actual value to patients; (5) patient's ability to pay.

It is recommended that a schedule of fixed fees be adopted with as few categories as possible, probably one, two or three. One hospital has two basic modalities. Most rates today range from $2 to $5 for a treatment. Deviations should not be made from the fixed schedule in making charges to patients.

Complications of Colles' Fractures. Lenox D. Baker, and Howard J. Schaubel.

North Carolina M. J. **7**:457 (Sept.) 1946.

Disuse of the injured extremity leads to loss of joint motion and causes more disability than does the original injury. To avoid these complications, the patient should be taught one or several exercises immediately following reduction of the fracture. (By "immediately" is meant before the patient leaves the fracture room following the reduction.) Limitation of motion in the shoulder, elbow and finger joints is the result of improper treatment and not of the injury. There are several groups of exercises that may be used to insure complete motility of these joints. Any or all of these exercises can be used with satisfaction provided the patient is cooperative. One of the simplest exercises for the shoulder is circumduction with gravity eliminated. This is carried out as follows: As the patient supports a part of his weight with the uninjured hand on a table or the back of a chair, he bends forward sufficiently to allow the injured arm to hang perpendicularly. The shoulder is then carried through full circumduction. At first it may be necessary for the patient to have some assistance; this can be given by a nurse or a member of the family.

A simple exercise for the fingers can be supplied by allowing the patient to squeeze a soft rubber ball. This ball should be a bit smaller than the ordinary tennis ball and should be much softer.

There are several simple exercises which involve the use of all free joints of the injured extremity. In this exercise two glasses or capped jars containing different colored fluids are used. One is placed on a shelf in easy reach above the patient's head, the other on a table. The exercise consists in interchanging the places of the glasses a given number of times according to instructions. This exercise develops finger motion and grip and carries the shoulder and the elbow through full ranges of motion.

Placing the Handicapped. A Positive, Individual and Specific Approach. Bert Hanman.

Indust. Med. **15**:597 (Oct.) 1946.

Can you do the heavy lifting required of stevedores? Do you have the perfect vision required of pilots? Can you stand and walk all day as a counter clerk? If not, you are physically limited in the eyes of industry.

Any worker who does not possess the physical capacities to meet the physical demands of the most arduous job is physically limited to the degree that his capacities fall short of meeting the most arduous demands.

Many of us, therefore, are not supermen physi-

cally. Many of us are physically limited. It is easy, however, to reduce the problem and limit the number of physically handicapped by stricter definitions: only to those with gross disabilities; only to those whose disabilities present a special problem in placement, only to those disabled who need rehabilitation before employment is possible, only to those whose disabilities make them permanently unemployable.

It is easy, also, to confuse the issue with the common assertion that "a physically handicapped worker is no longer physically handicapped when he can fulfill the requirements of a suitable job." Statements to this effect are responsible for considerable bewilderment as to who is and who is not physically handicapped. The terms "physically handicapped, physically impaired physically restricted, physically limited" and "physically disabled" may be used synonymously and in personnel work refer to workers with reduced physical capacities. These terms, however, are confused frequently with the term "occupationally (or vocationally) handicapped." Occupations have numerous requirements, skill, experience, intelligence, educational, aptitude, interest, personality, emotional, physical and environmental requirements. Everyone is occupationally handicapped for all the jobs in which he can not meet all these requirements. When a physically handicapped worker can satisfy all the requirements of a job, he is not occupationally handicapped for that job. He remains, nevertheless, physically handicapped. A successful blind worker, for instance, remains blind. A capable physically handicapped worker, therefore, is physically handicapped but is not occupationally handicapped for the job in which he is successful. The misleading assertion should be corrected to read: "A physically handicapped worker is no longer occupationally handicapped when he can fulfill the requirements of a suitable job."

Studies on the Biological Effect of High Frequency Radio Waves (Radar). Richard H. Follis, Jr.

Am. J. Physiol. 147:281 (Oct. 1) 1946.

Soon after radar equipment came into general use in World War II, rumors began to circulate that deleterious effects were being produced among personnel routinely exposed to its high-frequency, short wavelength radiations. Although field investigations cast doubt that radar waves were a dangerous form of electromagnetic radiation, rumors persisted that sterilization or alopecia might result from such exposure. Inasmuch as this portion of the electromagnetic spectrum had not been explored biologically and because of the possibility that unshielded roentgen rays were emanating from the apparatus, experiments were undertaken by the Aero Medical Laboratory.

A radar sending unit, designated as Model No. SCR 517-A, was used as the source of the radiations. This unit was a peak output of 45 KW. The wavelength of the rays produced is 10 cm. The paraboloid antenna was placed two feet away from a stand which was divided into compartments in which the experimental animals were placed. Some of the compartments were shielded with copper sheeting to exclude the radar radiations. A recording device, consisting of a neon bulb and photo-electric cell, was placed in front of the source of rays and was connected to an amplifier and electric pen recorder which gave a continuous record in order to show whether the apparatus was in operation at all times during each exposure period.

Thirteen male guinea pigs were exposed to the radiation for three hours daily for fifty-one to fifty-three days. Four of these animals were shielded at all times by copper sheeting. Five male guinea pigs served as controls, being kept in the same room but shielded and away from the source of the radar waves. The animals were weighed weekly; rectal temperatures were recorded for a one week period before and after exposure to the radiations. At the conclusion of the experiments the males were mated to normal females. Following this the animals were sacrificed with ether.

Guinea pigs were exposed to ultrashort wave radiations (radar) for three hours daily for eight weeks. No effects were noted on the appearance, growth, body temperature or reproduction. Histologic examination of the tissues failed to reveal any changes.

Experiences With Late Trench Foot and Frostbite. Thomas J. Dry.

Nebraska State M. J. 31:443 (Nov.) 1946.

Impressed by the orthopedic nature of many of the late sequelae of cold injuries, the conclusion that active functional rehabilitation of feet should be of importance in recovery was arrived at early in the program and subsequent experience confirmed this beyond any doubt. The following plan was evolved to insure the application of this principle: The soldier must be convinced that exercising his feet will improve them and that complete recovery, while delayed at times for many months, depends largely on this. Walking and remedial exercises were insisted on from the day of admission. To insure full participation in and maximum benefit from remedial exercises, the following routine was established: a. Group demonstration by a member of the Department of Physical Therapy of correct manner of oiling and massaging the feet and of manipulating stiffened joints. b. Group exercises conducted in cadence by trained ward personnel. c. Individual supervision by the ward officer and trained ward personnel of refractory patients, who because of pain due to soft tissue swelling and the effects of disuse, found it difficult to bear weight or take more than a few steps at a time.

The cleansing of the feet of accumulated dirt, dead and desquamating skin, which acted like so many foreign bodies, made walking less painful This proved easier after soaking and washing with soap and water.

Proper fitting shoes were helpful in encouraging patients to take longer walks than they otherwise would have.

The treatment of patients with actual gangrene differed in no way from the groups described until they were ready for transfer to the surgical service.

Palmar Skin Resistance as a Measure of Physical Fitness. Edwin R. Elbel, and R. R. Ronkin.

Am. J. Physiol. **147**:1 (Sept.) 1946.

During past years research in the field of palmar skin resistance (PSR) has frequently been discussed under the inclusive heading of psychogalvanic phenomena. As used in this paper, PSR may be thought of as the impedance offered by the body to the passage of direct current from an external source, the potential difference being applied from the palm of one hand to the palm of the other.

The present study was conducted because of a recent suggestion that the Army Air Forces use PSR changes as a measure of physical fitness. The problem was approached from the standpoint of determining the reliability of PSR measurements and the validity of PSR as an index of physical fitness. Aviation students averaging 20.7 years of age, were used as experimental subjects. PSR data were secured while the subjects were at rest or while participating in certain kinds of physical activity. Pulse rate and skin temperature were obtained during certain parts of the study for comparison with PSR.

In general, PSR decreases during exercise and increases during rest. The decrement is more pronounced during intensive than during mild exercise. In the main, PSR shows an inverse relationship to pulse rate. The temperature of the electrolyte in which the hands are immersed influences PSR readings, but has no effect upon the reliability of the test.

Effects of Denervation on Fasciculations in Human Muscle—Relation of Fibrillations to Fasciculations. Francis M. Forster; Winslow J. Borkowski, and Bernard J. Alpers.

Arch. Neurol. & Psychiat. **56**:276 (Sept.) 1946.

In a previous communication evidence was presented to the effect that fasciculations in voluntary muscle have their site of origin not in the anterior horn cell but at the myoneural junction. This evidence consisted of the demonstration of continued fasciculations during pharmacologic block of the appropriate peripheral nerves or nerve roots and of the alternation of the frequency of fasciculations by drugs acting at the myoneural junction.

Subsequently, Denny-Brown mentioned the disadvantages of pharmacologic block and indicated that this type of block could not be considered absolute in the physiologic sense, for the drug employed need not affect all the fibers in a given nerve to the same degree nor could the interference with transmission of sensory or voluntary motor stimuli permit one to conclude that all impulses were blocked.

For these reasons, confirmatory evidence for the previous premise regarding the site of origin of fasciculations was sought. It was thought that this could be supplied by observations on muscles denervated by section of the motor nerve supply. It was also hoped that by these studies some light might be thrown on the confusing problem of the relationship, between fasciculations and fibrillations.

Remedial Correction of Valgus Foot Strain by Foot Pronation Exercise. E. T. Bailey, and B. S. Harrens.

Lancet **6423**:490 (Oct. 5) 1946.

The normal foot has been aptly compared to a tripod balanced evenly beneath the leg, with the os calcis in line with the astragalus and tibia. The maintenance of this balance depends on the ability of the foot to bring the head of the first metatarsal to the ground by adequate foot pronation. Should this pronation be deficient, the first metatarsal can only be brought down by a tilting of the whole foot outwards at the subastragaloid joint. This at once produces the characteristic appearance of "flat-foot," with valgus deviation of the foot as a whole and of the os calcis in particular. In such a position of imbalance it is not surprising that symptoms of foot and leg strain appear with rapid fatigue of muscles working at a mechanical disadvantage.

Restoration of normal foot balance with adequate foot pronation should therefore be the aim of treatment; and, though corrective osteotomy of the first metatarsal may be necessary in certain cases of congenital abnormality, it was felt by the authors that remedial treatment specifically directed to foot pronation could bring about the desired result. With this object in view, one of the authors (B. S. H.) has designed a foot corrector apparatus which ensures maintenance of the correct position of the os calcis during pronation exercises in a manner which is not possible with orthodox routine foot exercises.

The London College of Osteopathy. A. S. Blundell Bankart.

Brit. M. J. **4470**:344 (Sept. 7) 1946.

The present position of manipulative surgery as an integral part of orthopedic surgery is entirely due to Herbert Barker, who is not an osteopath and has never practiced osteopathy.

Bone-setting is an essentially British product which flourished in this country for 200 years before A. T. Still was born. Admittedly it was looked down on and neglected by the medical profession until Barker compelled attention to the good that there might be in it. The osteopaths were quick to take advantage of this and they have tried ever since to ride home on the backs of the bone-setters. But osteopathy has nothing whatever to do with bone-setting or manipulative surgery properly so called. It is a typical American stunt and its claims have been investigated up to the hilt and found wanting.

It is true that many osteopaths practice bone-setting or manipulative surgery and call it osteopathy. Obviously the manipulation of a stiff

foot, a knee, a shoulder, or a sacroiliac joint, if properly done, may be as successful in the hands of an osteopath as in those of a bone-setter or an orthopaedic surgeon, but it is not osteopathy. Even the manipulation of a back for chronic back-strain is not osteopathy, but straight forward manipulative surgery. The essence of osteopathy is the treatemnt of remote conditions by the "adjustment" of the osteopathic "lesions."

Mobilizing the Quadriceps to Increase Active Movement in Stiff Knees. M. Alexandroff.

Canad. M. A. J. **55**:390 (Oct.) 1946.

A method of operation for increasing the range of movement in stiff knees has been described by T. C. Thompson. In his article he states that it is beneficial for the patient to have had exercises to strengthen the quadriceps prior to operation. A special program is presented for patients with limited knee movement which results in only a few of the intractable cases requiring operation. It consists first of remedial exercises and secondly when necessary of injection of novocaine and manipulation.

The purpose of the exercises is to: (1) reeducate quadriceps group; (2) increase size of this muscle group; (3) use the results for increasing the angle of active movement in the affected joint. However, it was evident that many of these patients, if given sufficient and supervised instruction on specific exercises would be returned to civilian duty.

There were no cases that did not gain active movement at the time of treatment by this method. Eleven cases on follow-up show increase in the range of active movement following treatment.

Refrigeration in Surgery. Harold I. Miller, and Paul R. Miller.

Am. J. Surg. **72**:694 (Nov.) 1946.

The question whether refrigeration prolongs the survival time of anemic tissue remains unanswered. The evidence tends to show that it does. The only clinical report with pathologic studies (Richards) is equivocal because arterial insufficiency was established before refrigeration was applied.

The bacteriostatic action of cold in vivo is on a weak footing. In all the experimental studies cold was of no value. Clinically, it was. O'Neil's demonstration of the value of cold in a palmar infection in a patient with scleroderma and in a case of gas gangrene and on the other hand the appearance after refrigeration of gas gangrene in the stumps of two refrigerated limbs merely outlines the ramifications of the problem.

The published case histories praise the value of cold in shock. Blalock's studies tend to confirm this although his results are not conclusive.

In the elderly, toxic patient with gangrene and sepsis, amputation with a tourniquet and refrigeration gives excellent results. Here is the chief indication for refrigeration amputation. Pain and shock are eliminated and the operation is performed in a bloodless field. Even then one might wonder whether the tourniquet is not the chief reason for this. If such a patient had a tourniquet applied and received general treatment without refrigeration, when amputation were performed would the results be comparable? The work of Adolph among injured Chinese soldiers suggests that they would be. To those who have seen amputations performed under ice and tourniquet this is unlikely because there is yet no other single method for combating shock, holding infection in abeyance and producing anesthesia.

Use of Ultraviolet Light in Detection of Skin Changes. Herman Goodman.

J. A. M. A. **132**:104 (Sept. 14) 1946.

The articles on Wood's light fluorescence of the nails from quinacrine hydrochloride (atabrine) medication impel me to call attention to a little known mode of production of these zones of radiation. A conventional appearing incandescent bulb has become available. It operates on any house current through the usual outlet. The bulb is Westinghouse Purple X, 250 Watt, a 21 screw light socket. On either direct or alternating current this bulb produces ultraviolet radiation and some visible violet. It permits observation of fluorescence of the human skin, hair and nails in a darkened room or closet. The atabrine fluorescence is easily visible on the nails demarcated from the normal nail fluorescence.

The physician seeking a low cost fluorescent source will find this combination suitable for his needs. Its one great advantage over higher cost equipment is general availability on either direct or alternating current. Other advantages are that it can be easily carried from place to place, no time need be wasted waiting for build-up of lamp prior to first examination or between examinations, there is nothing to get out of order (always just when you need it) and it is one replacement unit.

Children Who Spend Too Long in Bed. J. A. McCluskie.

Lancet **6418**:302 (Aug. 31) 1946.

Nothing could be farther from an accurate opinion of sleep and its control than the idea, prevalent among doctors as well as laymen, that so long as we have plenty of sleep we are all right. The doctor will advise extra sleep during an illness or in convalescence, but will not tell the parents to discontinue the extra sleep when the child is well. As a result, the parents often institute permanently the early-to-bed habit which, with its helpmate early-to-rise, is undoubtedly one of the golden rules of life. But they omit the early rising, so poor Johnny has to adapt himself to an extra hour in bed which he does not need. Months afterwards he appears before the psychiatrist because he is talking or restless in his sleep, and the story is that the illness caused it.

Children of different ages react in different ways to being expected to sleep too long. Infants protest violently by crying vigorously if they are not

lifted, and into this group fall most of those babies whose mothers maintain that it is better to let them cry. If a baby has an hour too much sleep during the day it will certainly cry during the night. But the crying will be put down to feeding aberrations, certainly by the parents and probably by the doctor, too.

Toddlers show restlessness, crying and head-banging, and may develop other pastimes, such as thumb-sucking, masturbation and bed-wetting.

Children of school age acquire such symptoms as talking in their sleep, sleep-walking, and bed-wetting.

Boarding-schools and remand homes show uniformity in treatment of the 9 to 13 group, although remand-home boys seem to manage with less sleep than those in boarding-schools.

The excessive bedding indulged in by parents is not found in schools, however; and, in any case, community life is not so likely to encourage egocentric or introspective living.

Sympathectomy for Reflex Sympathetic Dystrophy. Report of Twenty-Nine Cases. James A. Evans.

J. A. M. A. **132**:620 (Nov. 16) 1946.

Sympathectomy was performed on 29 of 57 consecutive patients with reflex sympathetic dystrophy seen in the last five years. Eleven of the 57 patients received adequate relief by one or more sympathetic nerve blocks with procaine hydrochloride, sometimes reenforced by trigger block. Temporary relief by sympathetic nerve block with procaine hydrochloride indicates the need for sympathectomy. Failure to obtain relief by sympathetic nerve block with procaine hydrochloride makes relief by sympathectomy unlikely, even if other symptoms of sympathetic dystrophy besides pain are objectively present.

Twenty-two of 29 patients (76 per cent) on whom sympathectomy was performed for reflex sympathetic dystrophy obtained satisfactory to complete relief of pain. Two more patients received only slight relief of pain and need further surgical or physical therapeutic measures for complete relief, measures which we have found are more likely to succeed when the sympathetic pathway is cut. Sympathectomy should be done, therefore, before necessary local surgical procedures or painful physical therapeutic measures are attempted.

Peripheral Neuritis as a Complication of Penicillin Therapy. Lawrence C. Kolb, and Seymour J. Gray.

J. A. M. A. **132**:323 (Oct. 12) 1946.

The following cases, which were observed within a six month period, suggest that penicillin may cause injury to the peripheral nerves with resultant sensory and motor disturbances.

After treatment with physical therapy, complete recovery of function was observed three months after the onset of the palsy.

The treatment consisted of physical therapy. Four months after the onset of the palsy, only slight evidence of weakness of the extensors of the toes remained.

The patient was placed under treatment with light massage, and the arm was fixed in a neutral position by an airplane splint. Reexamination still disclosed evidence of atrophy and weakness of the previously mentioned muscles, although some voluntary contraction was present in the fibers of the anterior deltoid muscle. The patient had not been wearing his splint regularly, nor had he persisted with the physiotherapy. A diagnosis of neuritis of the right axillary and suprascapular nerves was made.

Treatment was instituted by placing the arm in abduction and providing physical therapy and vitamins. The patient was seen on neurologic consultation, at which time the only residual defect observed was a total loss of function of the serratus anterior muscle indicative of a persistent neuritis of the long thoracic nerve.

The Relationship of Physical Medicine to General Practice. George Morris Piersol.

J. A. M. A. **132**:565 (Nov. 9) 1946.

The gratifying and phenomenal progress which physical medicine has made during recent years has not been limited to an increased interest in and better understanding of this form of therapeutics. It has involved a gradual development of a much broader conception of the entire subject. This changed attitude is evidenced in the adoption of the term Physical Medicine as the appropriate designation for this field of practice, thus indicating that it is no longer restricted to treatment, since many of the procedures employed are of definite diagnostic value, particularly in the study of neuromuscular mechanisms. The term physical medicine now also includes occupational therapy, an indispensable adjunct to physical therapy.

In spite of the increased recognition and support which physical medicine has received from certain sources, it is a curious phenomenon that the great majority of physicians in this country have failed to show enthusiasm for or to take much interest in this branch of medicine.

Those veterans who during their service experience have learned the value of physical therapy will be justified in insisting on a continuation of such treatment from their family physicians.

It is a mistake to think that problems of reeducation or reconditioning are limited to disabilities incurred as the result of war.

Physical medicine has progressed to a point at which it must be considered a separate and distinct medical specialty. From this it may be logically concluded that the physician who has devoted time and special study to this subject may justly be regarded as a specialist in physical medicine, occupying a position comparable to that of others especially qualified in the various fields of medicine and surgery. It has recently been suggested that the term "physiatrist" be adopted as a suitable designation for physicians who are properly qualified in this specialty.